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PTO/SB/05 (2/98)

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UTILITY PATENT APPLICATION TRANSMITTAL <i>(Only for new nonprovisional applications under 37 CFR 1.53(h))</i>	Attorney Docket No.	04983.0024.US01/38-21(15092)B
	First Named Inventor or Application Identifier	BHAT
	Title	Nucleic Acid Molecules And Other Molecules Associated With the Tocopherol Pathway
	Express Mail Label No.	

APPLICATION ELEMENTS <i>See MPEP chapter 600 concerning utility patent application contents</i>	Assistant Commissioner for Patents ADDRESS TO: Box Patent Application Washington, DC 20231
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1. <input type="checkbox"/> *Fee Transmittal Form (Form PTO-1082) <i>(Submit an original and a duplicate for fee processing)</i>	6. <input type="checkbox"/> Microfiche Computer Program <i>(Appendix)</i>
2. <input checked="" type="checkbox"/> Specification [Total Pages 260] <i>(preferred arrangement set forth below)</i> <ul style="list-style-type: none">- Descriptive title of the Invention- Cross References to Related Applications- Statement Regarding Fed sponsored R&D- Reference to Microfiche Appendix- Background of the Invention- Brief Summary of the Invention- Brief Description of the Drawings (if filed)- Detailed Description- Claims- Abstract of the Disclosure	7. Nucleotide and/or Amino Acid Sequence Submission <i>(if applicable, all necessary)</i> <ul style="list-style-type: none">a. <input checked="" type="checkbox"/> Computer Readable Copyb. <input checked="" type="checkbox"/> Paper Copy (identical to computer copy)c. <input checked="" type="checkbox"/> Statement verifying identity of above copies
3. <input type="checkbox"/> Drawing(s) <i>(35 USC 113)</i> [Total Sheets <input type="text"/>	ACCOMPANYING APPLICATION PARTS 8. <input type="checkbox"/> Assignment Papers (cover sheet & document(s)) 9. <input type="checkbox"/> 37 CFR 3.73(b) Statement <input type="checkbox"/> Power of Attorney <i>(when there is an assignee)</i> 10. <input type="checkbox"/> English Translation Document <i>(if applicable)</i> 11. <input type="checkbox"/> Information Disclosure Statement (IDS)/PTO-1449 <input type="checkbox"/> Copies of IDS Citations 12. <input type="checkbox"/> Preliminary Amendment 13. <input checked="" type="checkbox"/> Return Receipt Postcard (MPEP 503) (Two) <i>(should be specifically itemized)</i> 14. <input type="checkbox"/> *Small Entity Statement(s) <input type="checkbox"/> Statement filed in prior application, Status still proper and desired 15. <input type="checkbox"/> Certified Copy of Priority Document(s) <i>(if foreign priority is claimed)</i> 16. <input type="checkbox"/> Other:
4. <input type="checkbox"/> Oath or Declaration [Total Pages <input type="text"/> <ul style="list-style-type: none">a. <input type="checkbox"/> Newly executed (original or copy)b. <input type="checkbox"/> Copy from a prior application (37 CFR 1.63(d)) <i>(for continuation/divisional with Box 17 completed)</i> <i>[Note Box 5 below]</i>i. <input type="checkbox"/> DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b)	
5. <input type="checkbox"/> Incorporation By Reference <i>(useable if Box 4b is checked)</i> The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.	
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17. If a CONTINUING APPLICATION , check appropriate box and supply the requisite information:	
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Prior Application Information: Examiner:	Group/Art Unit:

18. CORRESPONDENCE ADDRESS					
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Signature			Date	March 12, 1999	

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03/12/99
JC595 U.S. PTO
March 12, 1999

Assistant Commissioner for Patents
Washington, D.C. 20231

Box Patent Application

Re: U.S. Non-Provisional Utility Patent Application
Application No.: To Be Assigned
Filed: March 12, 1999
For: **Nucleic Acid Molecules and Other Molecules
Associated with the Tocopherol Pathway**
Inventors: Barkur G. Bhat *et al.*
Atty. Docket: 04983.0024.US01/38-21 (15092)B

Dear Sir:

The following documents are forwarded herewith for appropriate action by the U.S.
Patent and Trademark Office:

1. Utility Patent Application Transmittal (PTO/SB/05);
2. U.S. Utility Patent Application entitled:

**Nucleic Acid Molecules and Other Molecules Associated with the Tocopherol
Pathway**

and naming as inventors:

**Barkur G. Bhat, Sekhar S. Boddupalli, Ganesh M. Kishore, Jingdong Liu,
Shaukat H. Rangwala and Mylavaram Venkatramesh**

the application consisting of:

- a. A specification containing:
 - (i) 253 pages of description prior to the claims;
 - (ii) 217 pages of a sequence listing;
 - (iii) 6 pages of claims (9 claims);
 - (iv) a one (1) page abstract;


3. A computer readable disk copy of the sequence listing;
4. Statement Regarding Sequence Submission; and
5. Two (2) return postcards.

It is respectfully requested that, of the two attached postcards, one be stamped with the filing date of these documents and returned to our courier, and the other, prepaid postcard, be stamped with the filing date and unofficial application number and returned as soon as possible.

This application claims priority under 35 U.S.C §119(e) of application No. 60/078,031 filed March 16, 1998.

In accordance with 37 C.F.R. § 1.821(f), the paper copy of the sequence listing and the computer readable copy of the sequence listing submitted herewith in the above application are the same.

Respectfully submitted,



David R. Marsh (Reg. No. 41,408)
Erik B. Milch (Reg. No. 42,887)

Enclosures

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

Barkur G. Bhat *et al.*

Appln. No.: To Be Assigned

Filed: March 12, 1999

For: Nucleic Acid Molecules and Other
Molecules Associated with the
Tocopherol Pathway

Art Unit: To Be Assigned

Examiner: To Be Assigned

Atty. Docket: 04983.0024.US01/
38-21(15092)B

Statement Regarding Sequence Submission

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

In accordance with 37 C.F.R. § 1.821(f), the paper copy of the Sequence Listing and the computer readable copy of the Sequence Listing submitted herewith in the above-mentioned application are the same.

Respectfully submitted,



David R. Marsh (Reg. No. 41,408)

Erik B. Milch (Reg. No. 42,887)

Date: March 12, 1999

HOWREY & SIMON

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**NUCLEIC ACID MOLECULES AND OTHER MOLECULES ASSOCIATED WITH
THE TOCOPHEROL PATHWAY**

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority under 35 U.S.C. § 119(e) to application serial no.

5 60/078,031, which is herein incorporated by reference in its entirety.

FIELD OF THE INVENTION

10 The present invention is in the field of plant biochemistry. More specifically the invention relates to nucleic acid sequences from plant cells, in particular, nucleic acid sequences from maize and soybean plants associated with the tocopherol synthesis pathway in plants. The invention encompasses nucleic acid molecules that encode proteins and fragments of proteins. In addition, the invention also encompasses proteins and fragments of proteins so encoded and antibodies capable of binding these proteins or fragments. The invention also relates to methods of using the nucleic acid molecules, proteins and fragments of proteins and antibodies, for example for genome mapping, gene identification and analysis, plant breeding, preparation of constructs for use in plant gene expression and transgenic plants.

BACKGROUND OF THE INVENTION

I. TOCOPHEROL SYNTHESIS PATHWAY

15 The chloroplast of higher plants exhibit interconnected biochemical pathways that lead to secondary metabolites, including tocopherols, that not only perform functions in plants but can
20 also be important for mammalian nutrition. In plastids, tocopherols account up to 40% of the total quinone pool. The biosynthetic pathway of α -tocopherol in higher plants involves condensation of homogentisic acid and phytylpyrophosphate to form 2-methyl-6

phytylbenzoquinol (Fiedler *et al.*, *Planta* 155: 511-515 (1982); Soll *et al.*, *Arch. Biochem. Biophys.* 204: 544-550 (1980); Marshall *et al.*, *Phytochem.* 24: 1705-1711 (1985), all of which are herein incorporated by reference in their entirety). The plant tocopherol biosynthetic pathway can be divided into four parts: synthesis of homogentisic acid, which contributes to the aromatic ring of tocopherol; synthesis of phytylpyrophosphate, which contributes to the side chain of tocopherol; cyclization which plays a role in chirality and chromanol substructure of the vitamin E family; and S-adenosyl methionine dependent methylation of an aromatic ring, which effects the compositional quality of the vitamin E family.

Homogentisate is an aromatic precursor in the biosynthesis of tocopherols in chloroplasts and is formed from the aromatic shikimate metabolite, p-hydroxyphenylpyruvate. The aromatic amino acids phenylalanine, tyrosine, and tryptophan are formed by a reaction sequence that initiates from the two carbohydrate precursors, D-erythrose 4-phosphate and phosphoenolpyruvate, via shikimate, and forms prearomatic and aromatic compounds (Bentley, *Critical Rev. Biochem. Mol. Biol.* 25: 307-384 (1990), the entirety of which is herein incorporated by reference). Approximately 20% of the total carbon fixed by green plants is routed through the shikimate pathway with end products being aromatic amino acids and other aromatic secondary metabolites such as flavonoids, vitamins, lignins, alkaloids, and phenolics (Herrmann, *Plant Physiol.* 107: 7-12 (1995), Kishore and Shah, *Ann. Rev. Biochem.* 57:67-663 (1988), both of which are herein incorporated by reference in their entirety). Various aspects of the shikimate pathway have been reviewed (Bentley, *Critical Rev. Biochem. Mol. Biol.* 25: 307-384 (1990); Herrmann, *Plant Physiol.* 107: 7-12 (1995); Kishore and Shah, *Ann. Rev. Biochem.* 57:67-663 (1988)).

The first reported committed reaction in the shikimate pathway is catalyzed by the enzyme 3-deoxyarabino-heptulosonate 7-phosphate synthase (also known as 3-deoxy-D-arabino-heptulosonate 7-phosphate synthase, deoxyarabino-heptulosonate-P-synthase, and DAHP synthase (EC. 4.1.2.15)), which has been reported to control carbon flow into the shikimate pathway. The plastid localized DAHP synthase catalyzes the formation of 3-deoxy-D-arabino-heptulosonate 7-phosphate by condensing D-erythrose 4-phosphate with phosphoenolpyruvate. DAHP synthase has been isolated from plant sources including carrot and potato. DAHP synthase has substrate specificity for D-erythrose 4-phosphate and phosphoenolpyruvate, is a dimer of subunits having a molecular weight of 53KD and is activated by Mn^{2+} (Herrmann, *Plant Physiol.* 107: 7-12 (1995)). Aromatic amino acids are not reported to act as feedback regulators. Purified DAHP synthase is activated by tryptophan and, to a lesser extent, by tyrosine in a hysteric fashion (Suzich *et al.*, *Plant Physiol.* 79: 765-770 (1985), the entirety of which is herein incorporated by reference).

The next reported enzyme in the shikimate pathway is 3-dehydroquinate synthase (EC 4.6.1.3), which catalyzes the formation of dehydroquinate, the first carbocyclic metabolite in the biosynthesis of aromatic amino acids, from the substrates D-erythrose 4-phosphate and phosphoenolpyruvate. The enzyme reaction involves a NAD (nicotinamide adenine dinucleotide) cofactor dependent oxidation-reduction, β -elimination, and an intramolecular aldol condensation. 3-dehydroquinate synthase has been purified from *Phaseolus mungo* seedlings and pea seedlings, has a native molecular weight of 66 KD and is a dimer (Yamamoto, *Phytochem.* 19: 779-802 (1980); Pompliano *et al.*, *J. Am. Chem. Soc.* 111: 1866-1871-1871 (1989), both of which are herein incorporated by reference in their entirety).

3-dehydroquinate dehydratase (EC 4.2.1.10) catalyzes the stereospecific syn-dehydration of dehydroquinate to dehydroshikimate and has been reported to be responsible for initiating the process of aromatization by introducing the first of three double bonds of the aromatic ring system. 3-dehydroquinate dehydratase has been cloned from *E. coli* (Duncan *et al.*, *Biochem. J.* 238:475-483 (1986), the entirety of which is herein incorporated by reference).

Shikimate dehydrogenase (EC 1.1.1.25) catalyzes the NADPH (reduced nicotinamide adenine dinucleotide phosphate)-dependent conversion of dehydroshikimate to shikimate. Bifunctional 3-dehydroquinate dehydratase-shikimate dehydrogenase has been reported in spinach, pea seedling, and Maize (Bentley, *Critical Rev. Biochem. Mol. Biol.* 25: 307-384 (1990), Kishore and Shah, *Ann. Rev. Biochem.* 57:67-663 (1988)). *E. coli* shikimate dehydrogenase has been reported to be a monomeric, monofunctional protein with a molecular weight of 32,000 daltons (Chaudhuri and Coggins, *Biochem. J.* 226:217-223 (1985), the entirety of which is herein incorporated by reference).

Shikimate kinase (EC 2.7.1.71) catalyzes the phosphorylation of shikimate to shikimate-3-phosphate. Shikimate kinase exists as isoforms in *E. coli* and *S. typhimurium*. Plant shikimate kinase has been partially purified from mung bean and sorghum (Bentley, *Critical Rev. Biochem. Mol. Biol.* 25: 307-384 (1990); Kishore and Shah, *Ann. Rev. Biochem.* 57:67-663 (1988)). Certain plant species accumulate shikimate and shikimate kinase may play a role in regulating flux in the tocopherol synthesis pathway.

5-Enolpyruvyl-shikimate-3-phosphate synthase (also known as enolpyruvyl-shikimate-P-synthase, and EPSPS (EC 2.5.1.19)) catalyzes the reversible transfer of the carboxyvinyl moiety of phosphoenolpyruvate to shikimate-3-phosphate, yielding 5-enolpyruvyl-shikimate-3-phosphate. 5-Enolpyruvyl-shikimate-3-phosphate synthase is a target of the broad spectrum,

nonselective, postemergence herbicide, glyphosate. Chemical modification studies indicate that lysine, arginine, and histidine residues are essential for activity of the enzyme (Kishore and Shah, *Ann. Rev. Biochem.* 57:67-663 (1988)). 5-Enolpyruvyl-shikimate-3-phosphate synthase has been isolated and characterized from microbial and plant sources including tomato, petunia, *Arabidopsis*, and *Brassica* (Kishore and Shah, *Ann. Rev. Biochem.* 57:67-663 (1988)).

Chorismate synthase (EC 4.6.1.4) catalyzes the conversion of 5-enolpyruvyl-shikimate-3-phosphate to chorismic acid and introduces a second double bond in an aromatic ring and a trans-1,4-elimination of inorganic phosphorous. Chorismate is the last reported common intermediate in the biosynthesis of aromatic compounds via the shikimate pathway. The enzyme reaction involves no change in the oxidation state of the substrate. Chorismate synthase from various sources requires a reduced flavin cofactor, FMNH₂ (reduced flavin mononucleotide) or FADH₂ (reduced flavin adenine dinucleotide), for catalytic activity (Bentley, *Critical Rev. Biochem. Mol. Biol.* 25: 307-384 (1990); Kishore and Shah, *Ann. Rev. Biochem.* 57:67-663 (1988)).

The next reported enzyme in the tocopherol biosynthetic pathway is chorismate mutase (EC 5.4.99.5), which catalyzes the conversion of chorismic acid to prephenic acid. Chorismic acid is a substrate for a number of enzymes involved in the biosynthesis of aromatic compounds. Plant chorismate mutase exists in two isoforms, chorismate mutase-1 and chorismate mutase-2, that differ in feedback regulation by aromatic amino acids (Singh *et al.*, *Arch. Biochem. Biophys.* 243: 374-384 (1985); Goers *et al.*, *Planta* 162: 109-124 (1984), both of which are herein incorporated by reference in their entirety). It has been reported that chloroplastic chorismate mutase-1 may play a role in biosynthesis of aromatic amino acids as this enzyme is activated by tyrosine and phenylalanine. Cytosolic isozyme chorismate mutase-2 is not regulated by aromatic amino acids and may play a role in providing the aromatic nucleus for synthesis of aromatic

secondary metabolites including tocopherol (d'Amato *et al.*, *Planta*, 162: 104-108 (1984), the entirety of which is herein incorporated by reference).

The metabolic pathways branch after prephenic acid and lead not only to phenylalanine and tyrosine, but also to a number of secondary metabolites. Tyrosine is synthesized from prephenate via either 4-hydroxyphenylpyruvate or arogenate. Both routes have been reported in plants (Bentley, *Critical Rev. Biochem. Mol. Biol.* 25: 307-384 (1990)).

The formation of 4-hydroxyphenylpyruvate from prephenate is catalyzed by prephenate dehydrogenase (EC 1.3.1.12 for NAD specific prephenate dehydrogenase and EC 1.3.1.13 for NADP specific prephenate dehydrogenase). 4-Hydroxyphenylpyruvate associated with tocopherol biosynthesis may also come from tyrosine pool by the action of tyrosine transaminase (EC 2.6.1.5) or L-amino acid oxidase (EC 1.4.3.2). Tyrosine transaminase catalyzes the pyridoxal-phosphate dependent conversion of L-tyrosine to 4-hydroxyphenylpyruvate. This reversible enzyme reaction transfers the amino group of tyrosine to 2-oxoglutarate to form 4-hydroxyphenylpyruvate and glutamate. L-amino acid oxidase (EC 1.4.3.2) catalyzes the conversion of tyrosine to 4-hydroxyphenylpyruvate by acting on the amino group of tyrosine with oxygen acting as an acceptor. L-amino acid oxidase is not specific to tyrosine. In *E. coli*, aromatic amino acid amino transferase (also referred to as aromatic-amino-acid transaminase (EC 2.6.1.57)) converts 4-hydroxyphenylpyruvate to tyrosine and plays a role in phenylalanine and tyrosine biosynthesis (Oue *et al.*, *J. Biochem. (Tokyo)* 121: 161-171 (1997); Soto-Urzuza *et al.*, *Can. J. Microbiol.* 42: 294-298 (1996); Hayashi *et al.*, *Biochemistry* 32: 12229-12239 (1993), all of which are herein incorporated by reference in their entirety).

Aspartic acid amino transferase or transaminase A (EC 2.6.1.1) exhibits a broad substrate specificity and may utilize phenylpyruvate or p-hydroxyphenylpyruvate to form phenylalanine

and tyrosine, respectively. Transaminase A has been characterized in *Aradidopsis* (Wilkie *et al.*, *Biochem J.* 319: 969-976 (1996); Wilkie *et al.*, *Plant Mol. Biol.* 27: 1227-1233 (1995), both of which are herein incorporated by reference in their entirety), rice (Song *et al.*, *DNA Res.* 3: 303-310 (1996), herein incorporated by reference in its entirety), *Panicum miliaceum* L (Taniguchi *et al.*, *Arch. Biochem. Biophys.* 318: 295-306 (1995), herein incorporated by reference in its entirety), *Lupinus angustifolius* (Winefield *et al.*, *Plant Physiol.* 104: 417-423 (1994), herein incorporated by reference in its entirety), and soybean (Wadsworth *et al.*, *Plant Mol. Biol.* 21: 993-1009 (1993), herein incorporated by reference in its entirety).

A precursor molecule, homogentisic acid, is produced in the chloroplast from the shikimate pathway intermediate p-hydroxyphenylpyruvate. p-Hydroxyphenylpyruvate dioxygenase (also known as 4-hydroxyphenylpyruvate dioxygenase (EC 1.13.11.27)) catalyzes the formation of homogentisate from hydroxyphenylpyruvate through an oxidative decarboxylation of the 2-oxoacid side chain accompanied by hydroxylation of the aromatic ring and a 1,2 migration of the carboxymethyl group. Norris *et al.* reported functional identification of a *pdsI* gene that encodes p-Hydroxyphenylpyruvate dioxygenase (Norris *et al.*, *Plant Cell* 7: 2139-2149 (1995), the entirety of which is herein incorporated by reference). p-Hydroxyphenylpyruvate dioxygenase has been cloned from *Arabidopsis* and carrot (GenBank accession numbers U89267, AF000228, and U87257; Garcia *et al.*, *Biochem. J.* 325: 761-769 (1997), herein incorporated by reference in its entirety). Fiedler *et al.* reported the localization and presence of this enzyme in both isolated spinach chloroplast and the peroxisome (Fiedler *et al.*, *Planta*, 155: 511-515 (1982)). Garcia *et al.* reported the purification of the cytosolic form of hydroxyphenylpyruvate dioxygenase from cultured carrot protoplast (Garcia *et al.*, *Biochem. J.* 325: 761-769 (1997), the entirety of which is herein incorporated by reference). It has been

reported that the chloroplastic isoform may be involved in the biosynthesis of prenylquinones, and that the peroxisomal and cytosolic isoform may be involved in the degradation of tyrosine.

The carbon flow to the pool of phytol, *i.e.*, the isoprene-derived side chain of tocopherol, occurs via the mevalonate pathway or non-mevalonate pathway. Geranylgeranyl-pyrophosphate synthase (GGPP synthase (EC 2.5.1.29)) catalyzes the formation of geranylgeranylpyrophosphate by prenyltransferring an isoprene moiety from isopentenylpyrophosphate to farnesylpyrophosphate. A gene encoding geranylgeranyl-pyrophosphate synthase has been isolated from *Arabidopsis* and *Cantharanthus roseus* (Zhu *et al.*, *Plant Cell Physiol.* 38: 357-361 (1997), Bantignies *et al.*, *Plant Physiol.* 110: 336-336 (1995), both of which are herein incorporated by reference in their entirety). Geranylgeranylpyrophosphate synthesized by GGPP synthase is used in the carotenoid and tocopherol biosynthesis pathways.

The NADPH-dependent hydrogenation of geranylgeranylpyrophosphate is catalyzed by geranylgeranylpyrophosphate hydrogenase (also called geranylgeranylpyrophosphate reductase) to form phytylpyrophosphate (Soll *et al.*, *Plant Physiol.* 71: 849-854 (1983), the entirety of which is herein incorporated by reference). Geranylgeranylpyrophosphate hydrogenase appears to be localized to two sites: the chloroplast envelope and the thylakoids. The chloroplast envelope form is reported to be responsible for the hydrogenation of geranylgeranylpyrophosphate to a phytyl moiety. The thylakoids form is reported to be responsible for the stepwise reduction of chlorophyll esterified with geranylgeraniol to chlorophyll esterified with phytol. The chloroplast envelope form of geranylgeranylpyrophosphate may play a role in tocopherol and phylloquinone synthesis. A *chlP* gene cloned from *Synechocystis* has been functionally assigned by complementation in

Rhodobactor sphaeroids to catalyze the stepwise hydrogenation of geranylgeraniol to phytol (Addlesse *et al.*, *FEBS Lett.* 389: 126-130 (1996), the entirety of which is herein incorporated by reference).

Homogentisate:phytyl transferase (also referred to as phytyl/prenyltransferase) catalyzes the decarboxylation followed by condensation of homogentisic acid with a phytol moiety from phytylpyrophosphate to form 2-methyl-6 phytylbenzoquinol. Prenyltransferase activity has been reported in spinach chloroplasts and such activity is located in chloroplast envelope membranes (Fiedler *et al.*, *Planta* 155: 511-515 (1982)). A reported prenyltransferase gene, termed *pdsII*, specific to tocopherol biosynthesis has been identified in *Arabidopsis* (Norris *et al.*, *Plant Cell* 7: 2139-2149 (1995)).

Tocopherol cyclase catalyzes the cyclization of 2,3-dimethyl-6-phytylbenzoquinol to form γ -tocopherol and plays a role in the biosynthesis of enantioselective chromanol substructure of the vitamin E subfamily (Stocker *et al.*, *Bioorg. Medic. Chem.* 4: 1129-1134 (1996), the entirety of which is herein incorporated by reference). The preferred substrate specificity of tocopherol cyclase may be either 2,3-dimethyl-6-phytylbenzoquinol or 2-methyl-5-phytylbenzoquinol or both. The substrate, 2-methyl-6 phytylbenzoquinol, is formed by prenyltransferase and requires methylation by an *S*-adenosylmethionine-dependent methyltransferase before cyclization. Tocopherol cyclase has been purified from green algae chlorella protothecoids, *Dunaliella salina* and from wheat leaflets (U.S. Patent No. 5,432,069, the entirety of which is herein incorporated by reference).

Synthesis of γ -tocopherol from 2-methyl-6 phytylbenzoquinol occurs by two pathways with either δ -tocopherol or 2,3 dimethyl-5-phytylbenzoquinol acting as an intermediate. α -

Tocopherol is then synthesized from γ -tocopherol in a final methylation step with S-adenosylmethionine. These steps of α -tocopherol biosynthesis are located in the chloroplast membrane in higher plants. Formation of α -tocopherol from other tocopherols is catalyzed by S-adenosyl methionine (SAM)-dependent γ -tocopherol methyltransferase (EC 2.1.1.95). This enzyme has been partially purified from *Capsicum* and *Euglena gracilis* (Shigeoka *et al.*, *Biochim. Biophys. Acta* 1128: 220-226 (1992), d'Harlingue and Camara, *J. Biol. Chem.* 260: 15200-15203 (1985), both of which are herein incorporated by reference in their entirety).

Tocotrienols are similar to tocopherols in molecular structure except that there are three double bonds in the isoprenoid side chain. Although tocotrienols have not been reported in soybean, they are found within in the plant kingdom. The tocotrienol biosynthetic pathway is similar to that of tocopherol up to the formation of homogentisic. It has been reported that homogentisate:phytyl transferase is able to transfer geranylgeranyl-pyrophosphate ("GGPP") to homogentisic acid. A side chain of GGPP may be desaturated by the addition of phytylpyrophosphate to homogentisate. Stocker *et al.* report that a reduction of the side chain's double bond occurs at an earlier stage of the biosynthesis. Phytylpyrophosphate or GGPP are condensed with homogentisic acid ("HGA") to yield different hydroquinone precursors which are cyclized by the same enzyme (Stocker *et al.*, *Bioorg. Medicinal Chem.* 4:1129-1134 (1996), the entirety of which is herein incorporated by reference).

The primary oxidation product of tocopherol is tocopheryl quinone, which can be conjugated to yield glucuronate after prior reduction to the hydroquinone. In animals, glucuronate can be excreted into bile or further catabolized to tocopheronic acid in the kidney

and processed for urinary excretion (Traber and Sies, *Ann. Rev. Nutr.* 16:321-347 (1996), the entirety of which is herein incorporated by reference).

In *Aspergillus nidulans*, the aromatic amino acid catabolic pathway involves formation of homogentisic acid followed by aromatic ring cleavage by an homogentisic acid dioxygenase (EC 1.13.11.5) to yield, after an isomerization step, fumarylacetoacetate (Fernandez-Canon *et al.*, *Anal. Biochem.* 245: 218-22 (1997); Hudecova *et al.*, *Int. J. Biochem. Cell Biol.* 27: 1357-1363 (1995); Fernandez-Canon *et al.*, *J. Biol. Chem.* 270: 21199-21205 (1995), all of which are herein incorporated by reference in their entirety). Fumarylacetoacetate, is then split by fumarylacetoacetate (Fernandez-Canon and Penalva, *J. Biol. Chem.* 270:21199-21205 (1995), the entirety of which is herein incorporated by reference). Homogentisic acid dioxygenase uses a tocopherol biosynthetic metabolite homogentisic acid for hydrolysis.

Tocopherol levels are reported to vary in different plants, tissues, and developmental stages. The production of homogentisic acid by p-hydroxyphenylpyruvate dioxygenase may be a regulatory point for bulk flow through the pathway due to the irreversible nature of the enzyme reaction and due to the fact that homogentisic acid production is the first committed step in tocopherol biosynthesis (Norris *et al.*, *Plant Cell* 7: 2139-2149 (1995)). Another regulatory step in tocopherol biosynthesis may be associated with the availability of phytylpyrophosphate pool. Feeding studies in Safflower callus culture showed 1.8-fold and 18-fold increase in tocopherol synthesis by feeding homogentisate and phytol, respectively (Fury *et al.*, *Phytochem.* 26: 2741-2747 (1987), the entirety of which is herein incorporated by reference). In meadow rescue leaf, vitamin E increases in the initial phase of senescence when phytol is cleaved off from the chlorophylls and when a free phytol pool is available (Pesquier *et al.*, *J. Plant Physiol.* 135: 428-432 (1989), the entirety of which is herein incorporated by reference).

II. EXPRESSED SEQUENCE TAG NUCLEIC ACID MOLECULES

Expressed sequence tags, or ESTs are randomly sequenced members of a cDNA library (or complementary DNA)(McCombie *et al.*, *Nature Genetics* 1:124-130 (1992); Kurata *et al.*, *Nature Genetics* 8: 365-372 (1994); Okubo, *et al.* *Nature Genetics* 2: 173-179 (1992), all of which references are incorporated herein in their entirety). The randomly selected clones comprise insets that can represent a copy of up to the full length of a mRNA transcript.

Using conventional methodologies, cDNA libraries can be constructed from the mRNA (messenger RNA) of a given tissue or organism using poly dT primers and reverse transcriptase (Efstratiadis *et al.* *Cell* 7:279-288 (1976), the entirety of which is herein incorporated by reference; Higuchi *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 73:3146-3150 (1976), the entirety of which is herein incorporated by reference; Maniatis *et al.*, *Cell* 8:163-182 (1976) the entirety of which is herein incorporated by reference; Land *et al.*, *Nucleic Acids Res.* 9:2251-2266 (1981), the entirety of which is herein incorporated by reference; Okayama *et al.*, *Mol. Cell. Biol.* 2:161-170 (1982), the entirety of which is herein incorporated by reference; Gubler *et al.*, *Gene* 25:263-269 (1983), the entirety of which is herein incorporated by reference).

Several methods may be employed to obtain full-length cDNA constructs. For example, terminal transferase can be used to add homopolymeric tails of dC residues to the free 3' hydroxyl groups (Land *et al.*, *Nucleic Acids Res.* 9:2251-2266 (1981), the entirety of which is herein incorporated by reference). This tail can then be hybridized by a poly dG oligo which can act as a primer for the synthesis of full length second strand cDNA. Okayama and Berg, *Mol. Cell. Biol.* 2: 161-170 (1982), the entirety of which is herein incorporated by reference, report a method for obtaining full length cDNA constructs. This method has been simplified by using synthetic primer-adapters that have both homopolymeric tails for priming the synthesis of the

first and second strands and restriction sites for cloning into plasmids (Coleclough *et al.*, *Gene* 34:305-314 (1985), the entirety of which is herein incorporated by reference) and bacteriophage vectors (Krawinkel *et al.*, *Nucleic Acids Res.* 14:1913 (1986), the entirety of which is herein incorporated by reference; Han *et al.*, *Nucleic Acids Res.* 15:6304 (1987), the entirety of which is herein incorporated by reference).

These strategies have been coupled with additional strategies for isolating rare mRNA populations. For example, a typical mammalian cell contains between 10,000 and 30,000 different mRNA sequences (Davidson, *Gene Activity in Early Development*, 2nd ed., Academic Press, New York (1976). The number of clones required to achieve a given probability that a low-abundance mRNA will be present in a cDNA library is $N = (\ln(1-P))/(\ln(1-1/n))$ where N is the number of clones required, P is the probability desired, and 1/n is the fractional proportion of the total mRNA that is represented by a single rare mRNA (Sambrook *et al.*, *Molecular Cloning: A Laboratory Manual*, 2nd ed., Cold Spring Harbor Laboratory Press (1989), the entirety of which is herein incorporated by reference).

A method to enrich preparations of mRNA for sequences of interest is to fractionate by size. One such method is to fractionate by electrophoresis through an agarose gel (Pennica *et al.*, *Nature* 301:214-221 (1983), the entirety of which is herein incorporated by reference). Another such method employs sucrose gradient centrifugation in the presence of an agent, such as methylmercuric hydroxide, that denatures secondary structure in RNA (Schweinfest *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 79:4997-5000 (1982), the entirety of which is herein incorporated by reference).

A frequently adopted method is to construct equalized or normalized cDNA libraries (Ko, *Nucleic Acids Res.* 18:5705-5711 (1990), the entirety of which is herein incorporated by

reference; Patanjali, S. R. *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 88:1943-1947 (1991), the entirety of which is herein incorporated by reference). Typically, the cDNA population is normalized by subtractive hybridization (Schmid *et al.*, *J. Neurochem.* 48:307-312 (1987) the entirety of which is herein incorporated by reference; Fargnoli *et al.*, *Anal. Biochem.* 187:364-373 (1990) the
5 entirety of which is herein incorporated by reference; Travis *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 85:1696-1700 (1988) the entirety of which is herein incorporated by reference; Kato, *Eur. J. Neurosci.* 2:704-711 (1990); and Schweinfest *et al.*, *Genet. Anal. Tech. Appl.* 7:64-70 (1990), the entirety of which is herein incorporated by reference). Subtraction represents another method for reducing the population of certain sequences in the cDNA library (Swaroop *et al.*, *Nucleic Acids Res.* 19:1954 (1991), the entirety of which is herein incorporated by reference).

ESTs can be sequenced by a number of methods. Two basic methods may be used for DNA sequencing, the chain termination method of Sanger *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 74: 5463-5467 (1977), the entirety of which is herein incorporated by reference, and the chemical degradation method of Maxam and Gilbert, *Proc. Nat. Acad. Sci. (U.S.A.)* 74: 560-564 (1977), the entirety of which is herein incorporated by reference. Automation and advances in technology such as the replacement of radioisotopes with fluorescence-based sequencing have reduced the effort required to sequence DNA (Craxton, *Methods* 2: 20-26 (1991), the entirety of which is herein incorporated by reference; Ju *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 92: 4347-4351 (1995), the entirety of which is herein incorporated by reference; Tabor and Richardson,
20 *Proc. Natl. Acad. Sci. (U.S.A.)* 92: 6339-6343 (1995), the entirety of which is herein incorporated by reference). Automated sequencers are available from, for example, Pharmacia Biotech, Inc., Piscataway, New Jersey (Pharmacia ALF), LI-COR, Inc., Lincoln, Nebraska (LI-COR 4,000) and Millipore, Bedford, Massachusetts (Millipore BaseStation).

In addition, advances in capillary gel electrophoresis have also reduced the effort required to sequence DNA and such advances provide a rapid high resolution approach for sequencing DNA samples (Swerdlow and Gesteland, *Nucleic Acids Res.* 18:1415-1419 (1990); Smith, *Nature* 349:812-813 (1991); Luckey *et al.*, *Methods Enzymol.* 218:154-172 (1993); Lu *et al.*, *J. Chromatog. A.* 680:497-501 (1994); Carson *et al.*, *Anal. Chem.* 65:3219-3226 (1993); Huang *et al.*, *Anal. Chem.* 64:2149-2154 (1992); Kheterpal *et al.*, *Electrophoresis* 17:1852-1859 (1996); Quesada and Zhang, *Electrophoresis* 17:1841-1851 (1996); Baba, *Yakugaku Zasshi* 117:265-281 (1997), all of which are herein incorporated by reference in their entirety).

ESTs longer than 150 nucleotides have been found to be useful for similarity searches and mapping (Adams *et al.*, *Science* 252:1651-1656 (1991), herein incorporated by reference). ESTs, which can represent copies of up to the full length transcript, may be partially or completely sequenced. Between 150-450 nucleotides of sequence information is usually generated as this is length of sequence information that is routinely and reliably produced using single run sequence data. Typically, only single run sequence data is obtained from the cDNA library (Adams *et al.*, *Science* 252:1651-1656 (1991)). Automated single run sequencing typically results in an approximately 2-3% error or base ambiguity rate (Boguski *et al.*, *Nature Genetics* 4:332-333 (1993), the entirety of which is herein incorporated by reference).

EST databases have been constructed or partially constructed from, for example, *C. elegans* (McCombie *et al.*, *Nature Genetics* 1:124-131 (1992)), human liver cell line HepG2 (Okubo *et al.*, *Nature Genetics* 2:173-179 (1992)), human brain RNA (Adams *et al.*, *Science* 252:1651-1656 (1991)); Adams *et al.*, *Nature* 355:632-635 (1992)), *Arabidopsis*, (Newman *et al.*, *Plant Physiol.* 106:1241-1255 (1994)); and rice (Kurata *et al.*, *Nature Genetics* 8:365-372 (1994)).

III. SEQUENCE COMPARISONS

A characteristic feature of a protein or DNA sequence is that it can be compared with other known protein or DNA sequences. Sequence comparisons can be undertaken by determining the similarity of the test or query sequence with sequences in publicly available or proprietary databases (“similarity analysis”) or by searching for certain motifs (“intrinsic sequence analysis”)(e.g. *cis* elements)(Coulson, *Trends in Biotechnology* 12: 76-80 (1994), the entirety of which is herein incorporated by reference); Birren *et al.*, *Genome Analysis 1*: Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York 543-559 (1997), the entirety of which is herein incorporated by reference).

Similarity analysis includes database search and alignment. Examples of public databases include the DNA Database of Japan (DDBJ)(<http://www.ddbj.nig.ac.jp/>); Genbank (<http://www.ncbi.nlm.nih.gov/Web/Search/Index.html>); and the European Molecular Biology Laboratory Nucleic Acid Sequence Database (EMBL) (http://www.ebi.ac.uk/ebi_docs/embl_db/embl-db.html). A number of different search algorithms have been developed, one example of which are the suite of programs referred to as BLAST programs. There are five implementations of BLAST, three designed for nucleotide sequences queries (BLASTN, BLASTX, and TBLASTX) and two designed for protein sequence queries (BLASTP and TBLASTN) (Coulson, *Trends in Biotechnology* 12: 76-80 (1994); Birren *et al.*, *Genome Analysis 1*: Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York 543-559 (1997)).

BLASTN takes a nucleotide sequence (the query sequence) and its reverse complement and searches them against a nucleotide sequence database. BLASTN was designed for speed, not maximum sensitivity, and may not find distantly related coding sequences. BLASTX takes a

nucleotide sequence, translates it in three forward reading frames and three reverse complement reading frames, and then compares the six translations against a protein sequence database.

BLASTX is useful for sensitive analysis of preliminary (single-pass) sequence data and is tolerant of sequencing errors (Gish and States, *Nature Genetics* 3: 266-272 (1993), the entirety of which is herein incorporated by reference). BLASTN and BLASTX may be used in concert for analyzing EST data (Coulson, *Trends in Biotechnology* 12: 76-80 (1994); Birren *et al.*, *Genome Analysis* 1: 543-559 (1997)).

Given a coding nucleotide sequence and the protein it encodes, it is often preferable to use the protein as the query sequence to search a database because of the greatly increased sensitivity to detect more subtle relationships. This is due to the larger alphabet of proteins (20 amino acids) compared with the alphabet of nucleic acid sequences (4 bases), where it is far easier to obtain a match by chance. In addition, with nucleotide alignments, only a match (positive score) or a mismatch (negative score) is obtained, but with proteins, the presence of conservative amino acid substitutions can be taken into account. Here, a mismatch may yield a positive score if the non-identical residue has physical/chemical properties similar to the one it replaced. Various scoring matrices are used to supply the substitution scores of all possible amino acid pairs. A general purpose scoring system is the BLOSUM62 matrix (Henikoff and Henikoff, *Proteins* 17: 49-61 (1993), the entirety of which is herein incorporated by reference), which is currently the default choice for BLAST programs. BLOSUM62 is tailored for alignments of moderately diverged sequences and thus may not yield the best results under all conditions. Altschul, *J. Mol. Biol.* 36: 290-300 (1993), the entirety of which is herein incorporated by reference, describes a combination of three matrices to cover all contingencies. This may improve sensitivity, but at the expense of slower searches. In practice, a single

BLOSUM62 matrix is often used but others (PAM40 and PAM250) may be attempted when additional analysis is necessary. Low PAM matrices are directed at detecting very strong but localized sequence similarities, whereas high PAM matrices are directed at detecting long but weak alignments between very distantly related sequences.

5 Homologues in other organisms are available that can be used for comparative sequence analysis. Multiple alignments are performed to study similarities and differences in a group of related sequences. CLUSTAL W is a multiple sequence alignment package that performs progressive multiple sequence alignments based on the method of Feng and Doolittle, *J. Mol. Evol.* 25: 351-360 (1987), the entirety of which is herein incorporated by reference. Each pair of sequences is aligned and the distance between each pair is calculated; from this distance matrix, a guide tree is calculated, and all of the sequences are progressively aligned based on this tree. A feature of the program is its sensitivity to the effect of gaps on the alignment; gap penalties are varied to encourage the insertion of gaps in probable loop regions instead of in the middle of structured regions. Users can specify gap penalties, choose between a number of scoring matrices, or supply their own scoring matrix for both pairwise alignments and multiple alignments. CLUSTAL W for UNIX and VMS systems is available at: [ftp.ebi.ac.uk](ftp://ftp.ebi.ac.uk). Another program is MACAW (Schuler *et al.*, *Proteins Struct. Func. Genet.* 9:180-190 (1991), the entirety of which is herein incorporated by reference, for which both Macintosh and Microsoft Windows versions are available. MACAW uses a graphical interface, provides a choice of several alignment algorithms, and is available by anonymous ftp at: [ncbi.nlm.nih.gov](ftp://ncbi.nlm.nih.gov) (directory/pub/macaw).

Sequence motifs are derived from multiple alignments and can be used to examine individual sequences or an entire database for subtle patterns. With motifs, it is sometimes

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possible to detect distant relationships that may not be demonstrable based on comparisons of primary sequences alone. Currently, the largest collection of sequence motifs in the world is PROSITE (Bairoch and Bucher, *Nucleic Acid Research* 22: 3583-3589 (1994), the entirety of which is herein incorporated by reference). PROSITE may be accessed via either the ExPASy server on the World Wide Web or anonymous ftp site. Many commercial sequence analysis packages also provide search programs that use PROSITE data.

A resource for searching protein motifs is the BLOCKS E-mail server developed by S. Henikoff, *Trends Biochem Sci.* 18:267-268 (1993), the entirety of which is herein incorporated by reference; Henikoff and Henikoff, *Nucleic Acid Research* 19:6565-6572 (1991), the entirety of which is herein incorporated by reference; Henikoff and Henikoff, *Proteins*, 17: 49-61 (1993). BLOCKS searches a protein or nucleotide sequence against a database of protein motifs or "blocks." Blocks are defined as short, ungapped multiple alignments that represent highly conserved protein patterns. The blocks themselves are derived from entries in PROSITE as well as other sources. Either a protein query or a nucleotide query can be submitted to the BLOCKS server; if a nucleotide sequence is submitted, the sequence is translated in all six reading frames and motifs are sought for these conceptual translations. Once the search is completed, the server will return a ranked list of significant matches, along with an alignment of the query sequence to the matched BLOCKS entries.

Conserved protein domains can be represented by two-dimensional matrices, which measure either the frequency or probability of the occurrences of each amino acid residue and deletions or insertions in each position of the domain. This type of model, when used to search against protein databases, is sensitive and usually yields more accurate results than simple motif searches. Two popular implementations of this approach are profile searches (such as GCG

program ProfileSearch) and Hidden Markov Models (HMMs)(Krough. *et al.*, *J. Mol. Biol.* 235:1501-1531, (1994); Eddy, *Current Opinion in Structural Biology*, 6:361-365, (1996), both of which are herein incorporated by reference in their entirety). In both cases, a large number of common protein domains have been converted into profiles, as present in the PROSITE library, or HHM models, as in the Pfam protein domain library (Sonnhammer *et al.*, *Proteins* 28:405-420 (1997), the entirety of which is herein incorporated by reference). Pfam contains more than 500 HMM models for enzymes, transcription factors, signal transduction molecules, and structural proteins. Protein databases can be queried with these profiles or HMM models, which will identify proteins containing the domain of interest. For example, HMMSW or HMMFS, two programs in a public domain package called HMMER (Sonnhammer *et al.*, *Proteins* 28:405-420, (1997)) can be used.

PROSITE and BLOCKS represent collected families of protein motifs. Thus, searching these databases entails submitting a single sequence to determine whether or not that sequence is similar to the members of an established family. Programs working in the opposite direction compare a collection of sequences with individual entries in the protein databases. An example of such a program is the Motif Search Tool, or MoST (Tatusov *et al. Proc. Natl. Acad. Sci.* 91: 12091-12095 (1994), the entirety of which is herein incorporated by reference). On the basis of an aligned set of input sequences, a weight matrix is calculated by using one of four methods (selected by the user). A weight matrix is simply a representation, position by position of how likely a particular amino acid will appear. The calculated weight matrix is then used to search the databases. To increase sensitivity, newly found sequences are added to the original data set, the weight matrix is recalculated, and the search is performed again. This procedure continues until no new sequences are found.

SUMMARY OF THE INVENTION

The present invention provides a substantially purified nucleic acid molecule that encodes a maize or soybean tocopherol synthesis pathway enzyme or fragment thereof, wherein the maize or soybean tocopherol synthesis pathway enzyme is selected from the group consisting of: (a) deoxyarabiono-heptulosonate-P-synthase; (b) putative deoxyarabiono-heptulosonate-P-synthase; (c) dehydroquinase synthase; (d) dehydroquinase dehydratase; (e) putative dehydroquinase dehydratase; (f) shikimate dehydrogenase; (g) shikimate kinase; (h) enolpyruvylshikimate-P-synthase; (i) chorismate synthase; (j) chorismate mutase; (k) tyrosine transaminase; (l) putative tyrosine transaminase; (m) transaminase A; (n) putative Transaminase A; (o) 4-hydroxyphenylpyruvate dioxygenase; (p) homogentisic acid dioxygenase; and (q) geranylgeranylpyrophosphate synthase.

The present invention also provides a substantially purified nucleic acid molecule that encodes a plant tocopherol synthesis pathway enzyme or fragment thereof, wherein the nucleic acid molecule is selected from the group consisting of a nucleic acid molecule that encodes a maize or soybean deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean putative deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean dehydroquinase synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean dehydroquinase dehydratase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean putative dehydroquinase dehydratase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean shikimate dehydrogenase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or

soybean shikimate kinase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean enolpyruvylshikimate-P-synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean chorismate synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean chorismate mutase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean tyrosine transaminase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean putative Tyrosine transaminase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean transaminase A enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean putative transaminase A enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean 4-hydroxyphenylpyruvate dioxygenase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean homogentisic acid dioxygenase enzyme or fragment thereof; and a nucleic acid molecule that encodes a maize or soybean geranylgeranylpyrophosphate synthase enzyme or fragment thereof.

The present invention also provides a substantially purified maize or soybean tocopherol synthesis pathway enzyme or fragment thereof, wherein the maize or soybean tocopherol synthesis pathway enzyme is selected from the group consisting of (a) deoxyarabiono-heptulosonate-P-synthase or fragment thereof; (b) putative deoxyarabiono-heptulosonate-P-synthase or fragment thereof; (c) dehydroquinase synthase or fragment thereof; (d) dehydroquinase dehydratase or fragment thereof; (e) putative dehydroquinase dehydratase or fragment thereof; (f) shikimate dehydrogenase or fragment thereof; (g) shikimate kinase or fragment thereof; (h) enolpyruvylshikimate-P-synthase or fragment thereof; (i) chorismate synthase or fragment thereof; (j) chorismate mutase or fragment thereof; (k) tyrosine transaminase or fragment thereof; (l) putative tyrosine transaminase or fragment thereof; (m)

transaminase A or fragment thereof; (n) putative Transaminase A or fragment thereof; (o) 4-hydroxyphenylpyruvate dioxygenase or fragment thereof; (p) homogentisic acid dioxygenase or fragment thereof; and (q) geranylgeranylpyrophosphate synthase or fragment thereof.

5 The present invention also provides a substantially purified maize or soybean tocopherol synthesis pathway enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 1 through SEQ ID NO: 627.

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The present invention also provides a substantially purified maize or soybean deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 1 through SEQ ID NO: 97 and SEQ ID NO: 100 through SEQ ID NO: 146.

The present invention also provides a substantially purified maize or soybean deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof encoded by a nucleic acid sequence selected from the group consisting of SEQ ID NO: 1 through SEQ ID NO: 97 and SEQ ID NO: 100 through SEQ ID NO: 146.

20 The present invention also provides a substantially purified maize or soybean putative deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a

complement of SEQ ID NO: 98 through SEQ ID NO: 99 and SEQ ID NO: 147 through SEQ ID NO: 152.

5 The present invention also provides a substantially purified maize or soybean putative deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof encoded by a nucleic acid sequence selected from the group consisting of SEQ ID NO: 98 through SEQ ID NO: 99 and SEQ ID NO: 147 through SEQ ID NO: 152.

10 The present invention also provides a substantially purified maize dehydroquinate synthase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 153 through SEQ ID NO: 157.

15 The present invention also provides a substantially purified maize dehydroquinate synthase enzyme or fragment thereof encoded by a nucleic acid sequence selected from the group consisting of SEQ ID NO: 153 through SEQ ID NO: 157.

20 The present invention also provides a substantially purified soybean dehydroquinate dehydratase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence of a complement of SEQ ID NO: 160.

25 The present invention also provides a substantially purified soybean dehydroquinate dehydratase enzyme or fragment thereof encoded by a nucleic acid sequence of SEQ ID NO: 160.

The present invention also provides a substantially purified maize putative dehydroquinate dehydratase enzyme or fragment thereof encoded by a first nucleic acid molecule

which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 158 through SEQ ID NO: 159.

5 The present invention also provides a substantially purified maize putative dehydroquinase dehydratase enzyme or fragment thereof encoded by a nucleic acid sequence selected from the group consisting of SEQ ID NO: 158 through SEQ ID NO: 159.

10 The present invention also provides a substantially purified maize or soybean shikimate dehydrogenase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 158 through SEQ ID NO: 159 and SEQ ID NO: 160.

15 The present invention also provides a substantially purified maize or soybean shikimate dehydrogenase enzyme or fragment thereof encoded by a nucleic acid sequence selected from the group consisting of SEQ ID NO: 158 through SEQ ID NO: 159 and SEQ ID NO: 160.

20 The present invention also provides a substantially purified maize or soybean shikimate kinase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 161 through SEQ ID NO: 179 and SEQ ID NO: 180 through SEQ ID NO: 183.

25 The present invention also provides a substantially purified maize or soybean shikimate kinase enzyme or fragment thereof encoded by a nucleic acid sequence selected from the group consisting of SEQ ID NO: 161 through SEQ ID NO: 179 and SEQ ID NO: 180 through SEQ ID NO: 183.

5 The present invention also provides a substantially purified maize enolpyruvylshikimate-P-synthase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 184 through SEQ ID NO: 198.

The present invention also provides a substantially purified maize enolpyruvylshikimate-P-synthase enzyme or fragment thereof encoded by a nucleic acid sequence selected from the group consisting of SEQ ID NO: 184 through SEQ ID NO: 198.

10 The present invention also provides a substantially purified maize or soybean chorismate synthase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 199 through SEQ ID NO: 231 and SEQ ID NO: 232 through SEQ ID NO: 255.

15 The present invention also provides a substantially purified maize or soybean chorismate synthase enzyme or fragment thereof encoded by a nucleic acid sequence selected from the group consisting of SEQ ID NO: 199 through SEQ ID NO: 231 and SEQ ID NO: 232 through SEQ ID NO: 255.

20 The present invention also provides a substantially purified maize or soybean chorismate mutase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 256 through SEQ ID NO: 277 and SEQ ID NO: 278 through SEQ ID NO: 284.

The present invention also provides a substantially purified maize or soybean chorismate mutase enzyme or fragment thereof encoded by a nucleic acid sequence selected from the group consisting of SEQ ID NO: 256 through SEQ ID NO: 277 and SEQ ID NO: 278 through SEQ ID NO: 284.

5 The present invention also provides a substantially purified maize tyrosine transaminase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 285 through SEQ ID NO: 286.

10 The present invention also provides a substantially purified maize tyrosine transaminase enzyme or fragment thereof encoded by a nucleic acid sequence selected from the group consisting of SEQ ID NO: 285 through SEQ ID NO: 286.

15 The present invention also provides a substantially purified maize or soybean putative tyrosine transaminase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 287 through SEQ ID NO: 292 and SEQ ID NO: 293 through SEQ ID NO: 300.

20 The present invention also provides a substantially purified maize or soybean putative tyrosine transaminase enzyme or fragment thereof encoded by a nucleic acid sequence selected from the group consisting of SEQ ID NO: 287 through SEQ ID NO: 292 and SEQ ID NO: 293 through SEQ ID NO: 300.

The present invention also provides a substantially purified maize or soybean transaminase A enzyme or fragment thereof encoded by a first nucleic acid molecule which

specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 301 through SEQ ID NO: 474 and SEQ ID NO: 475 through SEQ ID NO: 581.

5 The present invention also provides a substantially purified maize or soybean transaminase A enzyme or fragment thereof encoded by a nucleic acid sequence selected from the group consisting of SEQ ID NO: 301 through SEQ ID NO: 474 and SEQ ID NO: 475 through SEQ ID NO: 581.

The present invention also provides a substantially purified soybean putative transaminase A enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 582 through SEQ ID NO: 597.

The present invention also provides a substantially purified soybean putative transaminase A enzyme or fragment thereof encoded by a nucleic acid sequence selected from the group consisting of SEQ ID NO: 582 through SEQ ID NO: 597.

15 The present invention also provides a substantially purified maize or soybean 4-hydroxyphenylpyruvate dioxygenase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a
20 complement of SEQ ID NO: 598 through SEQ ID NO: 600 and SEQ ID NO: 601 through SEQ ID NO: 607.

The present invention also provides a substantially purified maize or soybean 4-hydroxyphenylpyruvate dioxygenase enzyme or fragment thereof encoded by a nucleic acid

sequence selected from the group consisting of SEQ ID NO: 598 through SEQ ID NO: 600 and
SEQ ID NO: 601 through SEQ ID NO: 607.

5 The present invention also provides a substantially purified maize or soybean
homogentisic acid dioxygenase enzyme or fragment thereof encoded by a first nucleic acid
molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic
acid molecule having a nucleic acid sequence selected from the group consisting of a
complement of SEQ ID NO: 608 through SEQ ID NO: 615 and SEQ ID NO: 616 through SEQ
ID NO: 621.

10 The present invention also provides a substantially purified maize or soybean
homogentisic acid dioxygenase enzyme or fragment thereof encoded by a nucleic acid sequence
selected from the group consisting of SEQ ID NO: 608 through SEQ ID NO: 615 and SEQ ID
NO: 616 through SEQ ID NO: 621.

15 The present invention also provides a substantially purified maize or soybean
geranylgeranylpyrophosphate synthase enzyme or fragment thereof encoded by a first nucleic
acid molecule which specifically hybridizes to a second nucleic acid molecule, the second
nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a
complement of SEQ ID NO: 622 through SEQ ID NO: 624 and SEQ ID NO: 625 through SEQ
ID NO: 627.

20 The present invention also provides a substantially purified maize or soybean
geranylgeranylpyrophosphate synthase enzyme or fragment thereof encoded by a nucleic acid
sequence selected from the group consisting of SEQ ID NO: 622 through SEQ ID NO: 624 and
SEQ ID NO: 625 through SEQ ID NO: 627.

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The present invention also provides a purified antibody or fragment thereof which is capable of specifically binding to a maize or soybean tocopherol synthesis pathway enzyme or fragment thereof, wherein the maize or soybean tocopherol synthesis pathway enzyme or fragment thereof is encoded by a nucleic acid molecule comprising a nucleic acid sequence selected from the group consisting of SEQ ID NO: 1 through SEQ ID NO: 627.

The present invention also provides a substantially purified antibody or fragment thereof, the antibody or fragment thereof capable of specifically binding to a substantially purified maize or soybean deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 1 through SEQ ID NO: 97 and SEQ ID NO: 100 through SEQ ID NO: 146.

The present invention also provides a substantially purified antibody or fragment thereof, the antibody or fragment thereof capable of specifically binding to a maize or soybean putative deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 98 through SEQ ID NO: 99 and SEQ ID NO: 147 through SEQ ID NO: 152.

The present invention also provides a substantially purified antibody or fragment thereof, the antibody or fragment thereof capable of specifically binding to a maize dehydroquinase synthase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically

hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence consisting of a complement of SEQ ID NO: 153 through SEQ ID NO: 157.

The present invention also provides a substantially purified antibody or fragment thereof, the antibody or fragment thereof capable of specifically binding to a soybean dehydroquinase 5 dehydratase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 160.

The present invention also provides a substantially purified antibody or fragment thereof, the antibody or fragment thereof capable of specifically binding to a maize putative 10 dehydroquinase dehydratase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 158 through SEQ ID NO: 159.

The present invention also provides a substantially purified antibody or fragment thereof, the antibody or fragment thereof capable of specifically binding to a maize or soybean shikimate 15 dehydrogenase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 158 through SEQ ID NO: 159 and SEQ ID NO: 160. 20

The present invention also provides a substantially purified antibody or fragment thereof, the antibody or fragment thereof capable of specifically binding to a maize or soybean shikimate kinase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically

hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 161 through SEQ ID NO: 179 and SEQ ID NO: 180 through SEQ ID NO: 183.

5 The present invention also provides a substantially purified antibody or fragment thereof, the antibody or fragment thereof capable of specifically binding to a maize enolpyruvylshikimate-P-synthase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 184 through SEQ ID NO: 198.

10 The present invention also provides a substantially purified antibody or fragment thereof, the antibody or fragment thereof capable of specifically binding to a maize or soybean chorismate synthase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 199 through SEQ ID NO: 231 and SEQ ID NO: 232 through SEQ ID NO: 255.

15 The present invention also provides a substantially purified antibody or fragment thereof, the antibody or fragment thereof capable of specifically binding to a maize or soybean chorismate mutase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule
20 having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 256 through SEQ ID NO: 277 and SEQ ID NO: 278 through SEQ ID NO: 284.

The present invention also provides a substantially purified antibody or fragment thereof, the antibody or fragment thereof capable of specifically binding to a maize tyrosine transaminase

enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 285 through SEQ ID NO: 286.

5 The present invention also provides a substantially purified antibody or fragment thereof, the antibody or fragment thereof capable of specifically binding to a maize or soybean putative tyrosine transaminase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 287 through SEQ ID NO: 292 and SEQ ID NO: 293 through SEQ ID NO: 300.

10 The present invention also provides a substantially purified antibody or fragment thereof, the antibody or fragment thereof capable of specifically binding to a maize or soybean transaminase A enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 301 through SEQ ID NO: 474 and SEQ ID NO: 475 through SEQ ID NO: 581.

15 The present invention also provides a substantially purified antibody or fragment thereof, the antibody or fragment thereof capable of specifically binding to a soybean putative transaminase A enzyme or fragment thereof encoded by a first nucleic acid molecule which
20 specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 582 through SEQ ID NO: 597.

The present invention also provides a substantially purified antibody or fragment thereof, the antibody or fragment thereof capable of specifically binding to a maize or soybean 4-hydroxyphenylpyruvate dioxygenase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a
5 complement of SEQ ID NO: 598 through SEQ ID NO: 600 and SEQ ID NO: 601 through SEQ ID NO: 607.

The present invention also provides a substantially purified antibody or fragment thereof, the antibody or fragment thereof capable of specifically binding to a maize or soybean
10 homogentisic acid dioxygenase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a complement of SEQ ID NO: 608 through SEQ ID NO: 615 and SEQ ID NO: 616 through SEQ ID NO: 621.

The present invention also provides a substantially purified antibody or fragment thereof, the antibody or fragment thereof capable of specifically binding to a maize or soybean
15 geranylgeranylpyrophosphate synthase enzyme or fragment thereof encoded by a first nucleic acid molecule which specifically hybridizes to a second nucleic acid molecule, the second nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a
20 complement of SEQ ID NO: 622 through SEQ ID NO: 624 and SEQ ID NO: 625 through SEQ ID NO: 627.

The present invention also provides a transformed plant having a nucleic acid molecule which comprises: (A) an exogenous promoter region which functions in a plant cell to cause the

production of a mRNA molecule; (B) a structural nucleic acid molecule comprising a nucleic acid sequence selected from the group consisting of (a) a nucleic acid sequence which encodes for a deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; (b) a nucleic acid sequence which encodes for a putative deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; (c) a nucleic acid sequence which encodes for a dehydroquinase synthase enzyme or fragment thereof; (d) a nucleic acid sequence which encodes for a dehydroquinase dehydratase enzyme or fragment thereof; (e) a nucleic acid sequence which encodes for a putative dehydroquinase dehydratase enzyme or fragment thereof; (f) a nucleic acid sequence which encodes for a shikimate dehydrogenase enzyme or fragment thereof; (g) a nucleic acid sequence which encodes for a shikimate kinase enzyme or fragment thereof; (h) a nucleic acid sequence which encodes for an enolpyruvylshikimate-P-synthase enzyme or fragment thereof; (i) a nucleic acid sequence which encodes for a chorismate synthase enzyme or fragment thereof; (j) a nucleic acid sequence which encodes for a chorismate mutase enzyme or fragment thereof; (k) a nucleic acid sequence which encodes for a tyrosine transaminase enzyme or fragment thereof; (l) a nucleic acid sequence which encodes for a putative Tyrosine transaminase enzyme or fragment thereof; (m) a nucleic acid sequence which encodes for a transaminase A enzyme or fragment thereof; (n) a nucleic acid sequence which encodes for a putative transaminase A enzyme or fragment thereof; (o) a nucleic acid sequence which encodes for a 4-hydroxyphenylpyruvate dioxygenase enzyme or fragment thereof; (p) a nucleic acid sequence which encodes for a homogentisic acid dioxygenase enzyme or fragment thereof; (q) a nucleic acid sequence which encodes for a geranylgeranylpyrophosphate synthase enzyme or fragment thereof; and (r) a nucleic acid sequence which is complementary to any of the nucleic acid sequences of (a) through (q); and (C) a 3' non-translated sequence that functions in the plant cell

to cause termination of transcription and addition of polyadenylated ribonucleotides to a 3' end of the mRNA molecule.

The present invention also provides a transformed plant having a nucleic acid molecule which comprises: (A) an exogenous promoter region which functions in a plant cell to cause the production of a mRNA molecule; which is linked to (B) a structural nucleic acid molecule, wherein the structural nucleic acid molecule encodes a plant tocopherol synthesis pathway enzyme or fragment thereof, the structural nucleic acid molecule comprising a nucleic acid sequence selected from the group consisting of SEQ ID NO: 1 through SEQ ID NO: 627 or fragment thereof; which is linked to (C) a 3' non-translated sequence that functions in the plant cell to cause termination of transcription and addition of polyadenylated ribonucleotides to a 3' end of the mRNA molecule.

The present invention also provides a transformed plant having a nucleic acid molecule which comprises: (A) an exogenous promoter region which functions in a plant cell to cause the production of a mRNA molecule; which is linked to (B) a structural nucleic acid molecule, wherein the structural nucleic acid molecule is selected from the group consisting of a nucleic acid molecule that encodes for a deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; a nucleic acid molecule that encodes for a putative deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; a nucleic acid molecule that encodes for a dehydroquinase synthase enzyme or fragment thereof; a nucleic acid molecule that encodes for a dehydroquinase synthase enzyme or fragment thereof; a nucleic acid molecule that encodes for a dehydroquinase synthase enzyme or fragment thereof; a nucleic acid molecule that encodes for a putative dehydroquinase synthase enzyme or fragment thereof; a nucleic acid molecule that encodes for a putative dehydroquinase synthase enzyme or fragment thereof; a nucleic acid molecule that encodes for a shikimate dehydrogenase enzyme or fragment thereof; a nucleic acid molecule that encodes for a shikimate kinase enzyme or fragment thereof; a nucleic acid molecule that encodes for an

production of a mRNA molecule; which is linked to: (B) a transcribed nucleic acid molecule with a transcribed strand and a non-transcribed strand, wherein a transcribed mRNA of the transcribed strand is complementary to an endogenous mRNA molecule having a nucleic acid sequence selected from the group consisting of an endogenous mRNA molecule that encodes a maize or soybean deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize or soybean putative deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize dehydroquinase synthase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a soybean dehydroquinase dehydratase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize putative dehydroquinase dehydratase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize or soybean shikimate dehydrogenase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize or soybean shikimate kinase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize enolpyruvylshikimate-P-synthase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize or soybean chorismate synthase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize or soybean chorismate mutase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize tyrosine transaminase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize or soybean putative tyrosine transaminase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize or soybean transaminase A enzyme or fragment thereof; an endogenous mRNA molecule that encodes a soybean putative transaminase A enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize or soybean 4-hydroxyphenylpyruvate dioxygenase enzyme or fragment thereof; an endogenous mRNA

molecule that encodes a maize or soybean homogentisic acid dioxygenase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize or soybean geranylgeranylpyrophosphate synthase enzyme or fragment thereof; which is linked to (C) a 3' non-translated sequence that functions in the plant cell to cause termination of transcription and addition of polyadenylated ribonucleotides to a 3' end of the mRNA molecule.

The present invention also provides a method for determining a level or pattern of a plant tocopherol synthesis pathway enzyme in a plant cell or plant tissue comprising: (A) incubating, under conditions permitting nucleic acid hybridization, a marker nucleic acid molecule, the marker nucleic acid molecule having a nucleic acid sequence selected from the group consisting of SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof or fragment of either, with a complementary nucleic acid molecule obtained from the plant cell or plant tissue, wherein nucleic acid hybridization between the marker nucleic acid molecule and the complementary nucleic acid molecule obtained from the plant cell or plant tissue permits the detection of the plant tocopherol synthesis pathway enzyme; (B) permitting hybridization between the marker nucleic acid molecule and the complementary nucleic acid molecule obtained from the plant cell or plant tissue; and (C) detecting the level or pattern of the complementary nucleic acid, wherein the detection of the complementary nucleic acid is predictive of the level or pattern of the plant tocopherol synthesis pathway enzyme.

The present invention also provides a method for determining a level or pattern of a plant tocopherol synthesis pathway enzyme in a plant cell or plant tissue comprising: (A) incubating, under conditions permitting nucleic acid hybridization, a marker nucleic acid molecule, the marker nucleic acid molecule comprising a nucleic acid molecule that encodes a maize or soybean deoxyarabiono-heptulosonate-P-synthase enzyme or complement thereof or fragment of

complement thereof or fragment of either, with a complementary nucleic acid molecule obtained from the plant cell or plant tissue, wherein nucleic acid hybridization between the marker nucleic acid molecule and the complementary nucleic acid molecule obtained from the plant cell or plant tissue permits the detection of the plant tocopherol synthesis pathway enzyme; (B) permitting hybridization between the marker nucleic acid molecule and the complementary nucleic acid molecule obtained from the plant cell or plant tissue; and (C) detecting the level or pattern of the complementary nucleic acid, wherein the detection of the complementary nucleic acid is predictive of the level or pattern of the plant tocopherol synthesis pathway enzyme.

The present invention also provides a method for determining a level or pattern of a plant tocopherol synthesis pathway enzyme in a plant cell or plant tissue under evaluation which comprises assaying the concentration of a molecule, whose concentration is dependent upon the expression of a gene, the gene specifically hybridizes to a nucleic acid molecule having a nucleic acid sequence selected from the group consisting of SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof, in comparison to the concentration of that molecule present in a reference plant cell or a reference plant tissue with a known level or pattern of the plant tocopherol synthesis pathway enzyme, wherein the assayed concentration of the molecule is compared to the assayed concentration of the molecule in the reference plant cell or reference plant tissue with the known level or pattern of the plant tocopherol synthesis pathway enzyme.

The present invention also provides a method for determining a level or pattern of a plant tocopherol synthesis pathway enzyme in a plant cell or plant tissue under evaluation which comprises assaying the concentration of a molecule, whose concentration is dependent upon the expression of a gene, the gene specifically hybridizes to a nucleic acid molecule selected from the group consisting of a nucleic acid molecule that encodes a maize or soybean deoxyarabiono-

concentration of the molecule in the reference plant cell or the reference plant tissue with the known level or pattern of the plant tocopherol synthesis pathway enzyme.

The present invention provides a method of determining a mutation in a plant whose presence is predictive of a mutation affecting a level or pattern of a protein comprising the steps:

- 5 (A) incubating, under conditions permitting nucleic acid hybridization, a marker nucleic acid, the marker nucleic acid selected from the group of marker nucleic acid molecules which specifically hybridize to a nucleic acid molecule having a nucleic acid sequence selected from the group of SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof or fragment of either and a complementary nucleic acid molecule obtained from the plant, wherein nucleic acid
- 10 hybridization between the marker nucleic acid molecule and the complementary nucleic acid molecule obtained from the plant permits the detection of a polymorphism whose presence is predictive of a mutation affecting the level or pattern of the protein in the plant; (B) permitting
- 15 hybridization between the marker nucleic acid molecule and the complementary nucleic acid molecule obtained from the plant; and (C) detecting the presence of the polymorphism, wherein the detection of the polymorphism is predictive of the mutation.

The present invention also provides a method for determining a mutation in a plant whose presence is predictive of a mutation affecting the level or pattern of a plant tocopherol synthesis pathway enzyme comprising the steps: (A) incubating, under conditions permitting nucleic acid hybridization, a marker nucleic acid molecule, the marker nucleic acid molecule comprising a

20 nucleic acid molecule that is linked to a gene, the gene specifically hybridizes to a nucleic acid molecule having a nucleic acid sequence selected from the group consisting of SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof and a complementary nucleic acid molecule obtained from the plant, wherein nucleic acid hybridization between the marker nucleic acid

molecule and the complementary nucleic acid molecule obtained from the plant permits the detection of a polymorphism whose presence is predictive of a mutation affecting the level or pattern of the plant tocopherol synthesis pathway enzyme in the plant; (B) permitting hybridization between the marker nucleic acid molecule and the complementary nucleic acid molecule obtained from the plant; and (C) detecting the presence of the polymorphism, wherein the detection of the polymorphism is predictive of the mutation.

The present invention also provides a method for determining a mutation in a plant whose presence is predictive of a mutation affecting the level or pattern of a plant tocopherol synthesis pathway enzyme comprising the steps: (A) incubating, under conditions permitting nucleic acid hybridization, a marker nucleic acid molecule, the marker nucleic acid molecule comprising a nucleic acid molecule that is linked to a gene, the gene specifically hybridizes to a nucleic acid molecule selected from the group consisting of a nucleic acid molecule that encodes a maize or soybean deoxyarabiono-heptulosonate-P-synthase enzyme or complement thereof; a nucleic acid molecule that encodes a maize or soybean putative deoxyarabiono-heptulosonate-P-synthase enzyme or complement thereof; a nucleic acid molecule that encodes a maize dehydroquate synthase enzyme or complement thereof; a nucleic acid molecule that encodes a soybean dehydroquate dehydratase enzyme or complement thereof; a nucleic acid molecule that encodes a maize putative dehydroquate dehydratase enzyme or complement thereof; a nucleic acid molecule that encodes a maize or soybean shikimate dehydrogenase enzyme or complement thereof; a nucleic acid molecule that encodes a maize or soybean shikimate kinase enzyme or complement thereof; a nucleic acid molecule that encodes a maize enolpyruvylshikimate-P-synthase enzyme or complement thereof; a nucleic acid molecule that encodes a maize or soybean chorismate synthase enzyme or complement thereof; a nucleic acid molecule that

encodes a maize or soybean chorismate mutase enzyme or complement thereof; a nucleic acid molecule that encodes a maize tyrosine transaminase enzyme or complement thereof; a nucleic acid molecule that encodes a maize or soybean putative tyrosine transaminase enzyme or complement thereof; a nucleic acid molecule that encodes a maize or soybean transaminase A enzyme or complement thereof; a nucleic acid molecule that encodes a soybean putative transaminase A enzyme or complement thereof; a nucleic acid molecule that encodes a maize or soybean 4-hydroxyphenylpyruvate dioxygenase enzyme or complement thereof; a nucleic acid molecule that encodes a maize or soybean homogentisic acid dioxygenase enzyme or complement thereof; a nucleic acid molecule that encodes a maize or soybean geranylgeranylpyrophosphate synthase enzyme or complement thereof, and a complementary nucleic acid molecule obtained from the plant, wherein nucleic acid hybridization between the marker nucleic acid molecule and the complementary nucleic acid molecule obtained from the plant permits the detection of a polymorphism whose presence is predictive of a mutation affecting the level or pattern of the plant tocopherol synthesis pathway enzyme in the plant; (B) permitting hybridization between the marker nucleic acid molecule and the complementary nucleic acid molecule obtained from the plant; and (C) detecting the presence of the polymorphism, wherein the detection of the polymorphism is predictive of the mutation.

The present invention also provides a method of producing a plant containing an overexpressed protein comprising: (A) transforming the plant with a functional nucleic acid molecule, wherein the functional nucleic acid molecule comprises a promoter region, wherein the promoter region is linked to a structural region, wherein the structural region has a nucleic acid sequence selected from group consisting of SEQ ID NO: 1 through SEQ ID NO: 627; wherein the structural region is linked to a 3' non-translated sequence that functions in the plant to cause

termination of transcription and addition of polyadenylated ribonucleotides to a 3' end of a mRNA molecule; and wherein the functional nucleic acid molecule results in overexpression of the protein; and (B) growing the transformed plant.

The present invention also provides a method of producing a plant containing an overexpressed plant tocopherol synthesis pathway enzyme comprising: (A) transforming the plant with a functional nucleic acid molecule, wherein the functional nucleic acid molecule comprises a promoter region, wherein the promoter region is linked to a structural region, wherein the structural region comprises a nucleic acid molecule having a nucleic acid sequence selected from the group consisting of SEQ ID NO: 1 through SEQ ID NO: 627 or fragment thereof; wherein the structural region is linked to a 3' non-translated sequence that functions in the plant to cause termination of transcription and addition of polyadenylated ribonucleotides to a 3' end of a mRNA molecule; and wherein the functional nucleic acid molecule results in overexpression of the plant tocopherol synthesis pathway enzyme; and (B) growing the transformed plant.

The present invention also provides a method of producing a plant containing an overexpressed plant tocopherol synthesis pathway enzyme comprising: (A) transforming the plant with a functional nucleic acid molecule, wherein the functional nucleic acid molecule comprises a promoter region, wherein the promoter region is linked to a structural region, wherein the structural region comprises a nucleic acid molecule selected from the group consisting of a nucleic acid molecule that encodes a maize or soybean deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean putative deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize dehydroquinase synthase enzyme or fragment

thereof; a nucleic acid molecule that encodes a soybean dehydroquinase dehydratase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize putative dehydroquinase dehydratase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean shikimate dehydrogenase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean shikimate kinase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize enolpyruvylshikimate-P-synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean chorismate synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean chorismate mutase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize tyrosine transaminase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean putative tyrosine transaminase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean transaminase A enzyme or fragment thereof; a nucleic acid molecule that encodes a soybean putative transaminase A enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean 4-hydroxyphenylpyruvate dioxygenase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean homogentisic acid dioxygenase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean geranylgeranylpyrophosphate synthase enzyme or fragment thereof; wherein the structural region is linked to a 3' non-translated sequence that functions in the plant to cause termination of transcription and addition of polyadenylated ribonucleotides to a 3' end of a mRNA molecule; and wherein the functional nucleic acid molecule results in overexpression of the plant tocopherol synthesis pathway enzyme; and (B) growing the transformed plant.

The present invention also provides a method of producing a plant containing reduced levels of a plant tocopherol synthesis pathway enzyme comprising: (A) transforming the plant

with a functional nucleic acid molecule, wherein the functional nucleic acid molecule comprises a promoter region, wherein the promoter region is linked to a structural region, wherein the structural region comprises a nucleic acid molecule having a nucleic acid sequence selected from the group consisting of SEQ ID NO: 1 through SEQ ID NO: 627; wherein the structural region is
5 linked to a 3' non-translated sequence that functions in the plant to cause termination of transcription and addition of polyadenylated ribonucleotides to a 3' end of a mRNA molecule; and wherein the functional nucleic acid molecule results in co-suppression of the plant tocopherol synthesis pathway enzyme; and (B) growing the transformed plant.

The present invention also provides a method of producing a plant containing reduced levels of a plant tocopherol synthesis pathway enzyme comprising: (A) transforming the plant with a functional nucleic acid molecule, wherein the functional nucleic acid molecule comprises a promoter region, wherein the promoter region is linked to a structural region, wherein the structural region comprises a nucleic acid molecule having a nucleic acid sequence selected from the group consisting of a nucleic acid molecule that encodes a maize or soybean deoxyarabiono-
10 heptulosonate-P-synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean putative deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize dehydroquinase synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a soybean dehydroquinase dehydratase enzyme or
15 fragment thereof; a nucleic acid molecule that encodes a maize putative dehydroquinase dehydratase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean shikimate dehydrogenase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean shikimate kinase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize enolpyruvylshikimate-P-synthase enzyme or fragment thereof; a
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nucleic acid molecule that encodes a maize or soybean chorismate synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean chorismate mutase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize tyrosine transaminase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean putative tyrosine transaminase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean transaminase A enzyme or fragment thereof; a nucleic acid molecule that encodes a soybean putative transaminase A enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean 4-hydroxyphenylpyruvate dioxygenase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean homogentisic acid dioxygenase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean geranylgeranylpyrophosphate synthase enzyme or fragment thereof, wherein the structural region is linked to a 3' non-translated sequence that functions in the plant to cause termination of transcription and addition of polyadenylated ribonucleotides to a 3' end of a mRNA molecule; and wherein the functional nucleic acid molecule results in co-suppression of the plant tocopherol synthesis pathway enzyme; and (B) growing the transformed plant.

The present invention also provides a method for reducing expression of a plant tocopherol synthesis pathway enzyme in a plant comprising: (A) transforming the plant with a nucleic acid molecule, the nucleic acid molecule having an exogenous promoter region which functions in a plant cell to cause the production of a mRNA molecule, wherein the exogenous promoter region is linked to a transcribed nucleic acid molecule having a transcribed strand and a non-transcribed strand, wherein the transcribed strand is complementary to a nucleic acid molecule having a nucleic acid sequence selected from the group consisting of SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof or fragments of either and the transcribed

strand is complementary to an endogenous mRNA molecule; and wherein the transcribed nucleic acid molecule is linked to a 3' non-translated sequence that functions in the plant cell to cause termination of transcription and addition of polyadenylated ribonucleotides to a 3' end of a mRNA molecule; and (B) growing the transformed plant.

5 The present invention also provides a method for reducing expression of a plant tocopherol synthesis pathway enzyme in a plant comprising: (A) transforming the plant with a nucleic acid molecule, the nucleic acid molecule having an exogenous promoter region which functions in a plant cell to cause the production of a mRNA molecule, wherein the exogenous promoter region is linked to a transcribed nucleic acid molecule having a transcribed strand and a non-transcribed strand, wherein a transcribed mRNA of the transcribed strand is complementary to a nucleic acid molecule selected from the group consisting of an endogenous mRNA molecule that encodes a maize or soybean deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize or soybean putative deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize dehydroquinase synthase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a soybean dehydroquinase dehydratase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize putative dehydroquinase dehydratase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize or soybean shikimate dehydrogenase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize or soybean shikimate kinase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize enolpyruvylshikimate-P-synthase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize or soybean chorismate synthase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize or

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soybean chorismate mutase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize tyrosine transaminase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize or soybean putative tyrosine transaminase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize or soybean transaminase A enzyme or fragment thereof; an endogenous mRNA molecule that encodes a soybean putative transaminase A enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize or soybean 4-hydroxyphenylpyruvate dioxygenase enzyme or fragment thereof; an endogenous mRNA molecule that encodes a maize or soybean homogentisic acid dioxygenase enzyme or fragment thereof; and an endogenous mRNA molecule that encodes a maize or soybean geranylgeranylpyrophosphate synthase enzyme or fragment thereof; and wherein the transcribed nucleic acid molecule is linked to a 3' non-translated sequence that functions in the plant cell to cause termination of transcription and addition of polyadenylated ribonucleotides to a 3' end of a mRNA molecule; and (B) growing the transformed plant.

The present invention also provides a method of determining an association between a polymorphism and a plant trait comprising: (A) hybridizing a nucleic acid molecule specific for the polymorphism to genetic material of a plant, wherein the nucleic acid molecule has a nucleic acid sequence selected from the group consisting of SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof or fragment of either; and (B) calculating the degree of association between the polymorphism and the plant trait.

The present invention also provides a method of determining an association between a polymorphism and a plant trait comprising: (A) hybridizing a nucleic acid molecule specific for the polymorphism to genetic material of a plant, wherein the nucleic acid molecule is selected from the group consisting of a nucleic acid molecule that encodes a maize or soybean

deoxyarabiono-heptulosonate-P-synthase enzyme or complement thereof or fragment of either; a
 nucleic acid molecule that encodes a maize or soybean putative deoxyarabiono-heptulosonate-P-
 synthase enzyme or complement thereof or fragment of either; a nucleic acid molecule that
 encodes a maize dehydroquate synthase enzyme or complement thereof or fragment of either; a
 5 nucleic acid molecule that encodes a soybean dehydroquate dehydratase enzyme or
 complement thereof or fragment of either; a nucleic acid molecule that encodes a maize putative
 dehydroquate dehydratase enzyme or complement thereof or fragment of either; a nucleic acid
 molecule that encodes a maize or soybean shikimate dehydrogenase enzyme or complement
 thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean shikimate
 kinase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes
 a maize enolpyruvylshikimate-P-synthase enzyme or complement thereof or fragment of either; a
 nucleic acid molecule that encodes a maize or soybean chorismate synthase enzyme or
 complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or
 soybean chorismate mutase enzyme or complement thereof or fragment of either; a nucleic acid
 molecule that encodes a maize tyrosine transaminase enzyme or complement thereof or fragment
 of either; a nucleic acid molecule that encodes a maize or soybean putative tyrosine transaminase
 enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a
 maize or soybean transaminase A enzyme or complement thereof or fragment of either; a nucleic
 acid molecule that encodes a soybean putative transaminase A enzyme or complement thereof or
 20 fragment of either; a nucleic acid molecule that encodes a maize or soybean 4-
 hydroxyphenylpyruvate dioxygenase enzyme or complement thereof or fragment of either; a
 nucleic acid molecule that encodes a maize or soybean homogentisic acid dioxygenase enzyme
 or complement thereof or fragment of either; and a nucleic acid molecule that encodes a maize or

soybean geranylgeranylpyrophosphate synthase enzyme or complement thereof or fragment of either; and (B) calculating the degree of association between the polymorphism and the plant trait.

The present invention also provides a method of isolating a nucleic acid that encodes a plant tocopherol synthesis pathway enzyme or fragment thereof comprising: (A) incubating under conditions permitting nucleic acid hybridization, a first nucleic acid molecule comprising a nucleic acid sequence selected from the group consisting of SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof or fragment of either with a complementary second nucleic acid molecule obtained from a plant cell or plant tissue; (B) permitting hybridization between the first nucleic acid molecule and the second nucleic acid molecule obtained from the plant cell or plant tissue; and (C) isolating the second nucleic acid molecule.

The present invention also provides a method of isolating a nucleic acid molecule that encodes a plant tocopherol synthesis pathway enzyme or fragment thereof comprising: (A) incubating under conditions permitting nucleic acid hybridization, a first nucleic acid molecule selected from the group consisting of a nucleic acid molecule that encodes a maize or soybean copalyl diphosphate synthase enzyme or complement thereof or fragment of either, a nucleic acid molecule that encodes a maize or soybean deoxyarabiono-heptulosonate-P-synthase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean putative deoxyarabiono-heptulosonate-P-synthase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize dehydroquate synthase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a soybean dehydroquate dehydratase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize putative dehydroquate dehydratase enzyme or

complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean shikimate dehydrogenase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean shikimate kinase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize

5 enolpyruvylshikimate-P-synthase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean chorismate synthase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean chorismate mutase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize tyrosine transaminase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean putative tyrosine transaminase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean transaminase A enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a soybean putative transaminase A enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean 4-

15 hydroxyphenylpyruvate dioxygenase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean homogentisic acid dioxygenase enzyme or complement thereof or fragment of either; and a nucleic acid molecule that encodes a maize or soybean geranylgeranylpyrophosphate synthase enzyme or complement thereof or fragment of either, with a complementary second nucleic acid molecule obtained from a plant cell or plant

20 tissue; (B) permitting hybridization between the plant tocopherol synthesis pathway enzyme nucleic acid molecule and the complementary nucleic acid molecule obtained from the plant cell or plant tissue; and (C) isolating the second nucleic acid molecule.

DETAILED DESCRIPTION OF THE INVENTION

Definitions and Agents of the Present Invention

Definitions:

As used herein, a tocopherol synthesis pathway enzyme is any enzyme that is associated
5 with the synthesis or degradation of tocopherol.

As used herein, a tocopherol synthesis enzyme is any enzyme that is associated with the
synthesis of tocopherol.

As used herein, a tocopherol degradation enzyme is any enzyme that is associated with
the degradation of tocopherol.

As used herein, deoxyarabinoheptulosonate phosphate synthase (DAHP synthase) is any
enzyme that catalyzes the formation of deoxyarabinoheptulosonate phosphate from erythrose
phosphate.

As used herein, dehydroquinate synthase is any enzyme that catalyzes the formation of
dehydroquinate from erythrose phosphate via an NAD-dependent reaction.

As used herein, dehydroquinate dehydratase is any enzyme that catalyzes the
stereospecific syn-dehydration of dehydroquinate to dehydroshikimate.

As used herein, shikimate dehydrogenase is any enzyme that catalyzes the NADPH-
dependent conversion of dehydroshikimate to shikimate.

As used herein, shikimate kinase is any enzyme that catalyzes the phosphorylation of
20 shikimate to shikimate-3-phosphate.

As used herein, enolpyruvylshikimatephosphate synthase (EPSPS) is any enzyme that
catalyzes the reversible transfer of the carboxyvinyl moiety of phosphoenolpyruvate to
shikimatephosphate, yielding enolpyruvylshikimate phosphate.

As used herein, chorismate synthase is any enzyme that catalyzes the conversion of enolpyruvylshikimate phosphate to chorismic acid with the introduction of a double bond of the aromatic ring in a trans-1,4-elimination of inorganic phosphorous.

As used herein, chorismate mutase is any enzyme that catalyzes the reaction that converts
5 chorismic acid to prephenic acid.

As used herein, prephenate dehydrogenase is any enzyme that catalyzes the formation of 4-hydroxyphenylpyruvate from prephenate via an NAD-dependent or an NADP-dependent reaction.

As used herein, tyrosine transaminase is any enzyme that catalyzes the pyridoxal-phosphate dependent conversion of L-tyrosine to 4-hydroxyphenylpyruvate.

As used herein, L-amino-acid oxidase is any enzyme that catalyzes the reaction to convert tyrosine to 4-hydroxyphenylpyruvate.

As used herein, aromatic amino acid amino transferase is any enzyme that catalyzes the reaction that converts 4-hydroxyphenylpyruvate to tyrosine.

As used herein, an aspartic acid amino transferase or transaminase A is any enzyme that catalyzes the formation of phenylalanine and tyrosine using phenylpyruvate or p-hydroxy phenylpyruvate, respectively.

As used herein, hydroxyphenylpyruvate dioxygenase is any enzyme that catalyzes the formation of homogentisate from phydroxyphenylpyruvate.

20 As used herein, geranylgeranyl-pyrophosphate synthase is any enzyme that catalyzes the formation of geranylgeranylpyrophosphate by prenyltransferring isoprene moiety from isopentenylpyrophosphate to farnesylpyrophosphate.

As used herein, geranylgeranylpyrophosphate (GGPP) hydrogenase is any enzyme that catalyzes the reaction to convert geranylgeranylpyrophosphate to phytylpyrophosphate via an NADPH-dependent reaction.

As used herein, homogentisate:phytyl transferase is any enzyme that catalyzes the reaction to convert homogentisic acid to 2-methyl-6-phytylbenzoquinol.

As used herein, tocopherol cyclase is any enzyme that catalyzes the cyclization of 2,3-dimethyl-6-phytylbenzoquinol to form γ -tocopherol.

As used herein, tocopherol methyltransferase is any enzyme that catalyzes the reaction that forms α -tocopherol from other tocopherols via an S-adenosyl methionine (SAM)-dependent reaction.

As used herein, homogentisic acid dioxygenase is any enzyme that catalyzes the reaction to convert homogentisic acid to fumarylacetoacetate.

Agents

(a) Nucleic Acid Molecules

Agents of the present invention include plant nucleic acid molecules and more preferably include maize and soybean nucleic acid molecules and more preferably include nucleic acid molecules of the maize genotypes B73 (Illinois Foundation Seeds, Champaign, Illinois U.S.A.), B73 x Mo17 (Illinois Foundation Seeds, Champaign, Illinois U.S.A.), DK604 (Dekalb Genetics, Dekalb, Illinois U.S.A.), H99 (Illinois Foundation Seeds, Champaign, Illinois U.S.A.), RX601 (Asgrow Seed Company, Des Moines, Iowa), Mo17 (Illinois Foundation Seeds, Champaign, Illinois U.S.A.), and soybean types Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa), C1944 (United States Department of Agriculture (USDA) Soybean Germplasm Collection,

Urbana, Illinois U.S.A.), Cristalina (USDA Soybean Germplasm Collection, Urbana, Illinois U.S.A.), FT108 (Monsoy, Brazil), Hartwig (USDA Soybean Germplasm Collection, Urbana, Illinois U.S.A.), BW211S Null (Tohoku University, Morioka, Japan), PI507354 (USDA Soybean Germplasm Collection, Urbana, Illinois U.S.A.), Asgrow A4922 (Asgrow Seed Company, Des Moines, Iowa U.S.A.), PI227687 (USDA Soybean Germplasm Collection, Urbana, Illinois U.S.A.), PI229358 (USDA Soybean Germplasm Collection, Urbana, Illinois U.S.A.) and Asgrow A3237 (Asgrow Seed Company, Des Moines, Iowa U.S.A.).

A subset of the nucleic acid molecules of the present invention includes nucleic acid molecules that are marker molecules. Another subset of the nucleic acid molecules of the present invention include nucleic acid molecules that encode a protein or fragment thereof. Another subset of the nucleic acid molecules of the present invention are EST molecules.

Fragment nucleic acid molecules may encode significant portion(s) of, or indeed most of, these nucleic acid molecules. Alternatively, the fragments may comprise smaller oligonucleotides (having from about 15 to about 250 nucleotide residues and more preferably, about 15 to about 30 nucleotide residues).

As used herein, an agent, be it a naturally occurring molecule or otherwise may be “substantially purified,” if desired, such that one or more molecules that is or may be present in a naturally occurring preparation containing that molecule will have been removed or will be present at a lower concentration than that at which it would normally be found.

The agents of the present invention will preferably be “biologically active” with respect to either a structural attribute, such as the capacity of a nucleic acid to hybridize to another nucleic acid molecule, or the ability of a protein to be bound by an antibody (or to compete with

another molecule for such binding). Alternatively, such an attribute may be catalytic and thus involve the capacity of the agent to mediate a chemical reaction or response.

The agents of the present invention may also be recombinant. As used herein, the term recombinant means any agent (e.g. DNA, peptide etc.), that is, or results, however indirect, from human manipulation of a nucleic acid molecule.

It is understood that the agents of the present invention may be labeled with reagents that facilitate detection of the agent (e.g. fluorescent labels, Prober *et al.*, *Science* 238:336-340 (1987); Albarella *et al.*, EP 144914; chemical labels, Sheldon *et al.*, U.S. Patent No. 4,582,789; Albarella *et al.*, U.S. Patent No. 4,563,417; modified bases, Miyoshi *et al.*, EP 119448, all of which are hereby incorporated by reference in their entirety).

It is further understood, that the present invention provides recombinant bacterial, mammalian, microbial, insect, fungal and plant cells and viral constructs comprising the agents of the present invention. (See, for example, Uses of the Agents of the Invention, Section (a) Plant Constructs and Plant Transformants; Section (b) Fungal Constructs and Fungal Transformants; Section (c) Mammalian Constructs and Transformed Mammalian Cells; Section (d) Insect Constructs and Transformed Insect Cells; and Section (e) Bacterial Constructs and Transformed Bacterial Cells)

Nucleic acid molecules or fragments thereof of the present invention are capable of specifically hybridizing to other nucleic acid molecules under certain circumstances. As used herein, two nucleic acid molecules are said to be capable of specifically hybridizing to one another if the two molecules are capable of forming an anti-parallel, double-stranded nucleic acid structure. A nucleic acid molecule is said to be the "complement" of another nucleic acid molecule if they exhibit complete complementarity. As used herein, molecules are said to

exhibit "complete complementarity" when every nucleotide of one of the molecules is complementary to a nucleotide of the other. Two molecules are said to be "minimally complementary" if they can hybridize to one another with sufficient stability to permit them to remain annealed to one another under at least conventional "low-stringency" conditions.

5 Similarly, the molecules are said to be "complementary" if they can hybridize to one another with sufficient stability to permit them to remain annealed to one another under conventional "high-stringency" conditions. Conventional stringency conditions are described by Sambrook *et al.*, *Molecular Cloning*, A Laboratory Manual, 2nd Ed., Cold Spring Harbor Press, Cold Spring Harbor, New York (1989) and by Haymes *et al.*, *Nucleic Acid Hybridization, A Practical Approach*, IRL Press, Washington, DC (1985), the entirety of which is herein incorporated by reference. Departures from complete complementarity are therefore permissible, as long as such departures do not completely preclude the capacity of the molecules to form a double-stranded structure. Thus, in order for a nucleic acid molecule to serve as a primer or probe it need only be sufficiently complementary in sequence to be able to form a stable double-stranded structure under the particular solvent and salt concentrations employed.

Appropriate stringency conditions which promote DNA hybridization, for example, 6.0 X sodium chloride/sodium citrate (SSC) at about 45°C, followed by a wash of 2.0 X SSC at 50°C, are known to those skilled in the art or can be found in *Current Protocols in Molecular Biology*, John Wiley & Sons, N.Y. (1989), 6.3.1-6.3.6. For example, the salt concentration in the wash
20 step can be selected from a low stringency of about 2.0 X SSC at 50°C to a high stringency of about 0.2 X SSC at 50°C. In addition, the temperature in the wash step can be increased from low stringency conditions at room temperature, about 22°C, to high stringency conditions at

about 65°C. Both temperature and salt may be varied, or either the temperature or the salt concentration may be held constant while the other variable is changed.

In a preferred embodiment, a nucleic acid of the present invention will specifically hybridize to one or more of the nucleic acid molecules set forth in SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof under moderately stringent conditions, for example at about 2.0 X SSC and about 65°C.

In a particularly preferred embodiment, a nucleic acid of the present invention will include those nucleic acid molecules that specifically hybridize to one or more of the nucleic acid molecules set forth in SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof under high stringency conditions such as 0.2 X SSC and about 65°C.

In one aspect of the present invention, the nucleic acid molecules of the present invention have one or more of the nucleic acid sequences set forth in SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof. In another aspect of the present invention, one or more of the nucleic acid molecules of the present invention share between 100% and 90% sequence identity with one or more of the nucleic acid sequences set forth in SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof. In a further aspect of the present invention, one or more of the nucleic acid molecules of the present invention share between 100% and 95% sequence identity with one or more of the nucleic acid sequences set forth in SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof. In a more preferred aspect of the present invention, one or more of the nucleic acid molecules of the present invention share between 100% and 98% sequence identity with one or more of the nucleic acid sequences set forth in SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof. In an even more preferred aspect of the present invention, one or more of the nucleic acid molecules of the present invention share between 100% and 99%

sequence identity with one or more of the sequences set forth in SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof.

In a further more preferred aspect of the present invention, one or more of the nucleic acid molecules of the present invention exhibit 100% sequence identity with a nucleic acid molecule present within MONN01, SATMON001, SATMON003 through SATMON014, SATMON016, SATMON017, SATMON019 through SATMON031, SATMON033, SATMON034, SATMON~001, SATMONN01, SATMONN04 through SATMONN06, CMz029 through CMz031, CMz033 through CMz037, CMz039 through CMz042, CMz044 through CMz045, CMz047 through CMz050, SOYMON001 through SOYMON038, Soy51 through Soy56, Soy58 through Soy62, Soy65 through Soy71, Soy 73 and Soy76 through Soy77 (Monsanto Company, St. Louis, Missouri U.S.A.).

(i) Nucleic Acid Molecules Encoding Proteins or Fragments Thereof

Nucleic acid molecules of the present invention can comprise sequences that encode a tocopherol synthesis pathway enzyme or fragment thereof. Such tocopherol synthesis pathway enzymes or fragments thereof include homologues of known tocopherol synthesis pathway enzymes in other organisms.

In a preferred embodiment of the present invention, a maize or soybean tocopherol synthesis pathway enzyme or fragment thereof of the present invention is a homologue of another plant tocopherol synthesis pathway enzyme. In another preferred embodiment of the present invention, a maize or soybean tocopherol synthesis pathway enzyme or fragment thereof of the present invention is a homologue of a fungal tocopherol synthesis pathway enzyme. In another preferred embodiment of the present invention, a maize or soybean tocopherol synthesis pathway enzyme or fragment thereof of the present invention is a homologue of a bacterial

tocopherol synthesis pathway enzyme. In another preferred embodiment of the present invention, a soybean tocopherol synthesis pathway enzyme or fragment thereof of the present invention is a homologue of a maize tocopherol synthesis pathway enzyme. In another preferred embodiment of the present invention, a maize tocopherol synthesis pathway enzyme homologue or fragment thereof of the present invention is a homologue of a soybean tocopherol synthesis pathway enzyme. In another preferred embodiment of the present invention, a maize or soybean tocopherol synthesis pathway enzyme homologue or fragment thereof of the present invention is a homologue of an *Arabidopsis thaliana* tocopherol synthesis pathway enzyme.

In a preferred embodiment of the present invention, the nucleic molecule of the present invention encodes a maize or soybean tocopherol synthesis pathway enzyme or fragment thereof where a maize or soybean tocopherol synthesis pathway enzyme exhibits a BLAST probability score of greater than 1E-12, preferably a BLAST probability score of between about 1E-30 and about 1E-12, even more preferably a BLAST probability score of greater than 1E-30 with its homologue.

In another preferred embodiment of the present invention, the nucleic acid molecule encoding a maize or soybean tocopherol synthesis pathway enzyme or fragment thereof exhibits a % identity with its homologue of between about 25% and about 40%, more preferably of between about 40 and about 70%, even more preferably of between about 70% and about 90% and even more preferably between about 90% and 99%. In another preferred embodiment of the present invention, a maize or soybean tocopherol synthesis pathway enzyme or fragments thereof exhibits a % identity with its homologue of 100%.

In a preferred embodiment of the present invention, the nucleic molecule of the present invention encodes a maize or soybean tocopherol synthesis pathway enzyme or fragment thereof

where a maize or soybean tocopherol synthesis pathway enzyme exhibits a BLAST score of greater than 120, preferably a BLAST score of between about 1450 and about 120, even more preferably a BLAST score of greater than 1450 with its homologue.

Nucleic acid molecules of the present invention also include non-maize, non-soybean homologues. Preferred non-maize, non-soybean homologues are selected from the group consisting of alfalfa, *Arabidopsis*, barley, *Brassica*, broccoli, cabbage, citrus, cotton, garlic, oat, oilseed rape, onion, canola, flax, an ornamental plant, pea, peanut, pepper, potato, rice, rye, sorghum, strawberry, sugarcane, sugarbeet, tomato, wheat, poplar, pine, fir, eucalyptus, apple, lettuce, lentils, grape, banana, tea, turf grasses, sunflower, oil palm and *Phaseolus*.

In a preferred embodiment, nucleic acid molecules having SEQ ID NO: 1 through SEQ ID NO: 627 or complements and fragments of either can be utilized to obtain such homologues.

The degeneracy of the genetic code, which allows different nucleic acid sequences to code for the same protein or peptide, is known in the literature. (U.S. Patent No. 4,757,006, the entirety of which is herein incorporated by reference).

In an aspect of the present invention, one or more of the nucleic acid molecules of the present invention differ in nucleic acid sequence from those encoding a maize or soybean tocopherol synthesis pathway enzyme or fragment thereof in SEQ ID NO: 1 through SEQ ID NO: 627 due to the degeneracy in the genetic code in that they encode the same tocopherol synthesis pathway enzyme but differ in nucleic acid sequence.

In another further aspect of the present invention, one or more of the nucleic acid molecules of the present invention differ in nucleic acid sequence from those encoding a maize or soybean tocopherol synthesis pathway enzyme or fragment thereof in SEQ ID NO: 1 through SEQ ID NO: 627 due to fact that the different nucleic acid sequence encodes a tocopherol

synthesis pathway enzyme having one or more conservative amino acid residue. Examples of conservative substitutions are set forth in Table 1. It is understood that codons capable of coding for such conservative substitutions are known in the art.

Table 1

<u>Original Residue</u>	<u>Conservative Substitutions</u>
Ala	Ser
Arg	Lys
Asn	Gln; His
Asp	Glu
Cys	Ser; Ala
Gln	Asn
Glu	Asp
Gly	Pro
His	Asn; Gln
Ile	Leu; Val
Leu	Ile; Val
Lys	Arg; Gln; Glu
Met	Leu; Ile
Phe	Met; Leu; Tyr
Ser	Thr
Thr	Ser
Trp	Tyr

Tyr

Trp; Phe

Val

Ile; Leu

In a further aspect of the present invention, one or more of the nucleic acid molecules of the present invention differ in nucleic acid sequence from those encoding a maize or soybean tocopherol synthesis pathway enzyme or fragment thereof set forth in SEQ ID NO: 1 through
5 SEQ ID NO: 627 or fragment thereof due to the fact that one or more codons encoding an amino acid has been substituted for a codon that encodes a nonessential substitution of the amino acid originally encoded.

Agents of the present invention include nucleic acid molecules that encode a maize or soybean tocopherol synthesis pathway enzyme or fragment thereof and particularly substantially purified nucleic acid molecules selected from the group consisting of a nucleic acid molecule that encodes a maize or soybean deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean putative deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize dehydroquate synthase enzyme or fragment thereof; a nucleic acid molecule that
15 encodes a soybean dehydroquate dehydratase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize putative dehydroquate dehydratase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean shikimate dehydrogenase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean shikimate kinase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize enolpyruvylshikimate-
20 P-synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean chorismate synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or

soybean chorismate mutase enzyme or fragment thereof; a nucleic acid molecule that encodes a
maize tyrosine transaminase enzyme or fragment thereof; a nucleic acid molecule that encodes a
maize or soybean putative tyrosine transaminase enzyme or fragment thereof; a nucleic acid
molecule that encodes a maize or soybean transaminase A enzyme or fragment thereof; a nucleic
acid molecule that encodes a soybean putative transaminase A enzyme or fragment thereof; a
nucleic acid molecule that encodes a maize or soybean 4-hydroxyphenylpyruvate dioxygenase
enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean
homogentisic acid dioxygenase enzyme or fragment thereof; a nucleic acid molecule that
encodes a maize or soybean geranylgeranylpyrophosphate synthase enzyme or fragment thereof.

Non-limiting examples of such nucleic acid molecules of the present invention are
nucleic acid molecules comprising: SEQ ID NO: 1 through SEQ ID NO: 627 or fragment thereof
that encode for a plant tocopherol synthesis pathway enzyme or fragment thereof, SEQ ID NO: 1
through SEQ ID NO: 97 and SEQ ID NO: 100 through SEQ ID NO: 146 or fragment thereof that
encodes for a maize or soybean deoxyarabiono-heptulosonate-P-synthase enzyme or fragment
thereof; SEQ ID NO: 98 through SEQ ID NO: 99 and SEQ ID NO: 147 through SEQ ID NO:
152 or fragment thereof that encodes for a maize or soybean putative deoxyarabiono-
heptulosonate-P-synthase enzyme or fragment thereof; SEQ ID NO: 153 through SEQ ID NO:
157 or fragment thereof that encodes for a maize dehydroquate synthase enzyme or fragment
thereof; SEQ ID NO: 160 or fragment thereof that encodes for a soybean dehydroquate
dehydratase enzyme or fragment thereof; SEQ ID NO: 158 through SEQ ID NO: 159 or fragment
thereof that encodes for a maize putative dehydroquate dehydratase enzyme or fragment
thereof; SEQ ID NO: 158 through SEQ ID NO: 159 and SEQ ID NO: 160 or fragment thereof
that encodes for a maize or soybean shikimate dehydrogenase enzyme or fragment thereof; SEQ

ID NO: 161 through SEQ ID NO: 179 and SEQ ID NO: 180 through SEQ ID NO: 183 or
fragment thereof that encodes for a maize or soybean shikimate kinase enzyme or fragment
thereof; SEQ ID NO: 184 through SEQ ID NO: 198 or fragment thereof that encodes for a maize
enolpyruvylshikimate-P-synthase enzyme or fragment thereof; SEQ ID NO: 199 through SEQ ID
5 NO: 231 and SEQ ID NO: 232 through SEQ ID NO: 255 or fragment thereof that encodes for a
maize or soybean chorismate synthase enzyme or fragment thereof; SEQ ID NO: 256 through
SEQ ID NO: 277 and SEQ ID NO: 278 through SEQ ID NO: 284 or fragment thereof that
encodes for a maize or soybean chorismate mutase enzyme or fragment thereof; SEQ ID NO:
285 through SEQ ID NO: 286 or fragment thereof that encodes for a maize tyrosine transaminase
enzyme or fragment thereof; SEQ ID NO: 287 through SEQ ID NO: 292 and SEQ ID NO: 293
through SEQ ID NO: 300 or fragment thereof that encodes for a maize or soybean putative
tyrosine transaminase enzyme or fragment thereof; SEQ ID NO: 301 through SEQ ID NO: 474
and SEQ ID NO: 475 through SEQ ID NO: 581 or fragment thereof that encodes for a maize or
soybean transaminase A enzyme or fragment thereof; SEQ ID NO: 582 through SEQ ID NO:
597 or fragment thereof that encodes for a soybean putative transaminase A enzyme or fragment
thereof; SEQ ID NO: 598 through SEQ ID NO: 600 and SEQ ID NO: 601 through SEQ ID NO:
607 or fragment thereof that encodes for a maize or soybean 4-hydroxyphenylpyruvate
dioxygenase enzyme or fragment thereof; SEQ ID NO: 608 through SEQ ID NO: 615 and SEQ
ID NO: 616 through SEQ ID NO: 621 or fragment thereof that encodes for a maize or soybean
20 homogentisic acid dioxygenase enzyme or fragment thereof; SEQ ID NO: 622 through SEQ ID
NO: 624 and SEQ ID NO: 625 through SEQ ID NO: 627 or fragment thereof that encodes for a
maize or soybean geranylgeranylpyrophosphate synthase enzyme or fragment thereof.

“Codominant markers” reveal the presence of two or more alleles (two per diploid individual) at a locus. “Dominant markers” reveal the presence of only a single allele per locus. The presence of the dominant marker phenotype (e.g., a band of DNA) is an indication that one allele is present in either the homozygous or heterozygous condition. The absence of the dominant marker phenotype (e.g. absence of a DNA band) is merely evidence that “some other” undefined allele is present. In the case of populations where individuals are predominantly homozygous and loci are predominately dimorphic, dominant and codominant markers can be equally valuable. As populations become more heterozygous and multi-allelic, codominant markers often become more informative of the genotype than dominant markers. Marker molecules can be, for example, capable of detecting polymorphisms such as single nucleotide polymorphisms (SNPs).

SNPs are single base changes in genomic DNA sequence. They occur at greater frequency and are spaced with a greater uniformity throughout a genome than other reported forms of polymorphism. The greater frequency and uniformity of SNPs means that there is greater probability that such a polymorphism will be found near or in a genetic locus of interest than would be the case for other polymorphisms. SNPs are located in protein-coding regions and noncoding regions of a genome. Some of these SNPs may result in defective or variant protein expression (e.g., as a results of mutations or defective splicing). Analysis (genotyping) of characterized SNPs can require only a plus/minus assay rather than a lengthy measurement, permitting easier automation.

SNPs can be characterized using any of a variety of methods. Such methods include the direct or indirect sequencing of the site, the use of restriction enzymes (Botstein *et al.*, *Am. J. Hum. Genet.* 32:314-331 (1980), the entirety of which is herein incorporated reference;

Konieczny and Ausubel, *Plant J.* 4:403-410 (1993), the entirety of which is herein incorporated by reference), enzymatic and chemical mismatch assays (Myers *et al.*, *Nature* 313:495-498 (1985), the entirety of which is herein incorporated by reference), allele-specific PCR (Newton *et al.*, *Nucl. Acids Res.* 17:2503-2516 (1989), the entirety of which is herein incorporated by reference; Wu *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 86:2757-2760 (1989), the entirety of which is herein incorporated by reference), ligase chain reaction (Barany, *Proc. Natl. Acad. Sci. (U.S.A.)* 88:189-193 (1991), the entirety of which is herein incorporated by reference), single-strand conformation polymorphism analysis (Labrune *et al.*, *Am. J. Hum. Genet.* 48: 1115-1120 (1991), the entirety of which is herein incorporated by reference), primer-directed nucleotide incorporation assays (Kuppuswami *et al.*, *Proc. Natl. Acad. Sci. USA* 88:1143-1147 (1991), the entirety of which is herein incorporated by reference), dideoxy fingerprinting (Sarkar *et al.*, *Genomics* 13:441-443 (1992), the entirety of which is herein incorporated by reference), solid-phase ELISA-based oligonucleotide ligation assays (Nikiforov *et al.*, *Nucl. Acids Res.* 22:4167-4175 (1994), the entirety of which is herein incorporated by reference), oligonucleotide fluorescence-quenching assays (Livak *et al.*, *PCR Methods Appl.* 4:357-362 (1995), the entirety of which is herein incorporated by reference), 5'-nuclease allele-specific hybridization TaqMan assay (Livak *et al.*, *Nature Genet.* 9:341-342 (1995), the entirety of which is herein incorporated by reference), template-directed dye-terminator incorporation (TDI) assay (Chen and Kwok, *Nucl. Acids Res.* 25:347-353 (1997), the entirety of which is herein incorporated by reference), allele-specific molecular beacon assay (Tyagi *et al.*, *Nature Biotech.* 16: 49-53 (1998), the entirety of which is herein incorporated by reference), PinPoint assay (Haff and Smirnov, *Genome Res.* 7: 378-388 (1997), the entirety of which is herein incorporated by reference) and

dCAPS analysis (Neff *et al.*, *Plant J.* 14:387-392 (1998), the entirety of which is herein incorporated by reference).

Additional markers, such as AFLP markers, RFLP markers and RAPD markers, can be utilized (Walton, *Seed World* 22-29 (July, 1993), the entirety of which is herein incorporated by reference; Burow and Blake, *Molecular Dissection of Complex Traits*, 13-29, Paterson (ed.), CRC Press, New York (1988), the entirety of which is herein incorporated by reference). DNA markers can be developed from nucleic acid molecules using restriction endonucleases, the PCR and/or DNA sequence information. RFLP markers result from single base changes or insertions/deletions. These codominant markers are highly abundant in plant genomes, have a medium level of polymorphism and are developed by a combination of restriction endonuclease digestion and Southern blotting hybridization. CAPS are similarly developed from restriction nuclease digestion but only of specific PCR products. These markers are also codominant, have a medium level of polymorphism and are highly abundant in the genome. The CAPS result from single base changes and insertions/deletions.

Another marker type, RAPDs, are developed from DNA amplification with random primers and result from single base changes and insertions/deletions in plant genomes. They are dominant markers with a medium level of polymorphisms and are highly abundant. AFLP markers require using the PCR on a subset of restriction fragments from extended adapter primers. These markers are both dominant and codominant are highly abundant in genomes and exhibit a medium level of polymorphism.

SSRs require DNA sequence information. These codominant markers result from repeat length changes, are highly polymorphic and do not exhibit as high a degree of abundance in the genome as CAPS, AFLPs and RAPDs SNPs also require DNA sequence information. These

codominant markers result from single base substitutions. They are highly abundant and exhibit a medium of polymorphism (Rafalski *et al.*, In: *Nonmammalian Genomic Analysis*, Birren and Lai (ed.), Academic Press, San Diego, CA, pp. 75-134 (1996), the entirety of which is herein incorporated by reference). It is understood that a nucleic acid molecule of the present invention
5 may be used as a marker.

A PCR probe is a nucleic acid molecule capable of initiating a polymerase activity while in a double-stranded structure to with another nucleic acid. Various methods for determining the structure of PCR probes and PCR techniques exist in the art. Computer generated searches using programs such as Primer3 (www-genome.wi.mit.edu/cgi-bin/primer/primer3.cgi), STSPipeline (www-genome.wi.mit.edu/cgi-bin/www-STS_Pipeline), or GeneUp (Pesole *et al.*, *BioTechniques* 25:112-123 (1998) the entirety of which is herein incorporated by reference), for example, can be used to identify potential PCR primers.

It is understood that a fragment of one or more of the nucleic acid molecules of the present invention may be a probe and specifically a PCR probe.

(b) Protein and Peptide Molecules

A class of agents comprises one or more of the protein or fragments thereof or peptide molecules encoded by SEQ ID NO: 1 through SEQ ID NO: 627 or one or more of the protein or fragment thereof and peptide molecules encoded by other nucleic acid agents of the present invention. As used herein, the term “protein molecule” or “peptide molecule” includes any
20 molecule that comprises five or more amino acids. It is well known in the art that proteins may undergo modification, including post-translational modifications, such as, but not limited to, disulfide bond formation, glycosylation, phosphorylation, or oligomerization. Thus, as used herein, the term “protein molecule” or “peptide molecule” includes any protein molecule that is

modified by any biological or non-biological process. The terms "amino acid" and "amino acids" refer to all naturally occurring L-amino acids. This definition is meant to include norleucine, ornithine, homocysteine and homoserine.

Non-limiting examples of the protein or fragment thereof of the present invention include

5 a maize or soybean tocopherol synthesis pathway enzyme or fragment thereof; a maize or soybean deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; a maize or soybean putative deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; a maize dehydroquate synthase enzyme or fragment thereof; a soybean dehydroquate dehydratase enzyme or fragment thereof; a maize putative dehydroquate dehydratase enzyme or fragment thereof; a maize or soybean shikimate dehydrogenase enzyme or fragment thereof; a maize or soybean shikimate kinase enzyme or fragment thereof; a maize enolpyruvylshikimate-P-synthase enzyme or fragment thereof; a maize or soybean chorismate synthase enzyme or fragment thereof; a maize or soybean chorismate mutase enzyme or fragment thereof; a maize tyrosine transaminase enzyme or fragment thereof; a maize or soybean putative tyrosine transaminase enzyme or fragment thereof; a maize or soybean transaminase A enzyme or fragment thereof; a soybean putative transaminase A enzyme or fragment thereof; a maize or soybean 4-hydroxyphenylpyruvate dioxygenase enzyme or fragment thereof; a maize or soybean homogentisic acid dioxygenase enzyme or fragment thereof; and a maize or soybean geranylgeranylpyrophosphate synthase enzyme or fragment thereof.

20 Non-limiting examples of the protein or fragment molecules of the present invention are a tocopherol synthesis pathway enzyme or fragment thereof encoded by: SEQ ID NO: 1 through SEQ ID NO: 627 or fragment thereof that encode for a tocopherol synthesis pathway enzyme or fragment thereof, SEQ ID NO: 1 through SEQ ID NO: 97 and SEQ ID NO: 100 through SEQ ID

NO: 146 or fragment thereof that encodes for a maize or soybean deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; SEQ ID NO: 98 through SEQ ID NO: 99 and SEQ ID NO: 147 through SEQ ID NO: 152 or fragment thereof that encodes for a maize or soybean putative deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; SEQ ID NO: 153 through SEQ ID NO: 157 or fragment thereof that encodes for a maize dehydroquate synthase enzyme or fragment thereof; SEQ ID NO: 160 or fragment thereof that encodes for a soybean dehydroquate dehydratase enzyme or fragment thereof; SEQ ID NO: 158 through SEQ ID NO: 159 or fragment thereof that encodes for a maize putative dehydroquate dehydratase enzyme or fragment thereof; SEQ ID NO: 158 through SEQ ID NO: 159 and SEQ ID NO: 160 or fragment thereof that encodes for a maize or soybean shikimate dehydrogenase enzyme or fragment thereof; SEQ ID NO: 161 through SEQ ID NO: 179 and SEQ ID NO: 180 through SEQ ID NO: 183 or fragment thereof that encodes for a maize or soybean shikimate kinase enzyme or fragment thereof; SEQ ID NO: 184 through SEQ ID NO: 198 or fragment thereof that encodes for a maize enolpyruvylshikimate-P-synthase enzyme or fragment thereof; SEQ ID NO: 199 through SEQ ID NO: 231 and SEQ ID NO: 232 through SEQ ID NO: 255 or fragment thereof that encodes for a maize or soybean chorismate synthase enzyme or fragment thereof; SEQ ID NO: 256 through SEQ ID NO: 277 and SEQ ID NO: 278 through SEQ ID NO: 284 or fragment thereof that encodes for a maize or soybean chorismate mutase enzyme or fragment thereof; SEQ ID NO: 285 through SEQ ID NO: 286 or fragment thereof that encodes for a maize tyrosine transaminase enzyme or fragment thereof; SEQ ID NO: 287 through SEQ ID NO: 292 and SEQ ID NO: 293 through SEQ ID NO: 300 or fragment thereof that encodes for a maize or soybean putative tyrosine transaminase enzyme or fragment thereof; SEQ ID NO: 301 through SEQ ID NO: 474 and SEQ ID NO: 475 through SEQ ID NO: 581 or fragment thereof that encodes for a

maize or soybean transaminase A enzyme or fragment thereof; SEQ ID NO: 582 through SEQ ID NO: 597 or fragment thereof that encodes for a soybean putative transaminase A enzyme or fragment thereof; SEQ ID NO: 598 through SEQ ID NO: 600 and SEQ ID NO: 601 through SEQ ID NO: 607 or fragment thereof that encodes for a maize or soybean 4-hydroxyphenylpyruvate dioxygenase enzyme or fragment thereof; SEQ ID NO: 608 through SEQ ID NO: 615 and SEQ ID NO: 616 through SEQ ID NO: 621 or fragment thereof that encodes for a maize or soybean homogentisic acid dioxygenase enzyme or fragment thereof; SEQ ID NO: 622 through SEQ ID NO: 624 and SEQ ID NO: 625 through SEQ ID NO: 627 or fragment thereof that encodes for a maize or soybean geranylgeranylpyrophosphate synthase enzyme or fragment thereof.

One or more of the protein or fragment of peptide molecules may be produced via chemical synthesis, or more preferably, by expressing in a suitable bacterial or eucaryotic host. Suitable methods for expression are described by Sambrook *et al.*, (In: *Molecular Cloning, A Laboratory Manual, 2nd Edition, Cold Spring Harbor Press*, Cold Spring Harbor, New York (1989)), or similar texts. For example, the protein may be expressed in, for example, Uses of the Agents of the Invention, Section (a) Plant Constructs and Plant Transformants; Section (b) Fungal Constructs and Fungal Transformants; Section (c) Mammalian Constructs and Transformed Mammalian Cells; Section (d) Insect Constructs and Transformed Insect Cells; and Section (e) Bacterial Constructs and Transformed Bacterial Cells.

A “protein fragment” is a peptide or polypeptide molecule whose amino acid sequence comprises a subset of the amino acid sequence of that protein. A protein or fragment thereof that comprises one or more additional peptide regions not derived from that protein is a “fusion” protein. Such molecules may be derivatized to contain carbohydrate or other moieties (such as

keyhole limpet hemocyanin, etc.). Fusion protein or peptide molecules of the present invention are preferably produced via recombinant means.

Another class of agents comprise protein or peptide molecules or fragments or fusions thereof encoded by SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof in which conservative, non-essential or non-relevant amino acid residues have been added, replaced or deleted. Computerized means for designing modifications in protein structure are known in the art (Dahiyat and Mayo, *Science* 278:82-87 (1997), the entirety of which is herein incorporated by reference).

The protein molecules of the present invention include plant homologue proteins. An example of such a homologue is a homologue protein of a non-maize or non-soybean plant species, that include but not limited to alfalfa, *Arabidopsis*, barley, *Brassica*, broccoli, cabbage, citrus, cotton, garlic, oat, oilseed rape, onion, canola, flax, an ornamental plant, pea, peanut, pepper, potato, rice, rye, sorghum, strawberry, sugarcane, sugarbeet, tomato, wheat, poplar, pine, fir, eucalyptus, apple, lettuce, lentils, grape, banana, tea, turf grasses, sunflower, oil palm, *Phaseolus* etc. Particularly preferred non-maize or non-soybean for use for the isolation of homologs would include, *Arabidopsis*, barley, cotton, oat, oilseed rape, rice, canola, ornamentals, sugarcane, sugarbeet, tomato, potato, wheat and turf grasses. Such a homologue can be obtained by any of a variety of methods. Most preferably, as indicated above, one or more of the disclosed sequences (SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof) will be used to define a pair of primers that may be used to isolate the homologue-encoding nucleic acid molecules from any desired species. Such molecules can be expressed to yield homologues by recombinant means.

(c) Antibodies

One aspect of the present invention concerns antibodies, single-chain antigen binding molecules, or other proteins that specifically bind to one or more of the protein or peptide molecules of the present invention and their homologues, fusions or fragments. Such antibodies
5 may be used to quantitatively or qualitatively detect the protein or peptide molecules of the present invention. As used herein, an antibody or peptide is said to “specifically bind” to a protein or peptide molecule of the present invention if such binding is not competitively inhibited by the presence of non-related molecules.

Nucleic acid molecules that encode all or part of the protein of the present invention can be expressed, via recombinant means, to yield protein or peptides that can in turn be used to elicit antibodies that are capable of binding the expressed protein or peptide. Such antibodies may be used in immunoassays for that protein. Such protein-encoding molecules, or their fragments may be a “fusion” molecule (i.e., a part of a larger nucleic acid molecule) such that, upon expression, a fusion protein is produced. It is understood that any of the nucleic acid molecules of the present invention may be expressed, via recombinant means, to yield proteins or peptides encoded by these nucleic acid molecules.

The antibodies that specifically bind proteins and protein fragments of the present invention may be polyclonal or monoclonal and may comprise intact immunoglobulins, or antigen binding portions of immunoglobulins fragments (such as (F(ab'), F(ab')₂), or single-chain
20 immunoglobulins producible, for example, via recombinant means. It is understood that practitioners are familiar with the standard resource materials which describe specific conditions and procedures for the construction, manipulation and isolation of antibodies (*see*, for example,

Harlow and Lane, In: *Antibodies: A Laboratory Manual*, Cold Spring Harbor Press, Cold Spring Harbor, New York (1988), the entirety of which is herein incorporated by reference).

Murine monoclonal antibodies are particularly preferred. BALB/c mice are preferred for this purpose, however, equivalent strains may also be used. The animals are preferably immunized with approximately 25 µg of purified protein (or fragment thereof) that has been emulsified in a suitable adjuvant (such as TiterMax adjuvant (Vaxcel, Norcross, GA)).

Immunization is preferably conducted at two intramuscular sites, one intraperitoneal site and one subcutaneous site at the base of the tail. An additional i.v. injection of approximately 25 µg of antigen is preferably given in normal saline three weeks later. After approximately 11 days following the second injection, the mice may be bled and the blood screened for the presence of anti-protein or peptide antibodies. Preferably, a direct binding Enzyme-Linked Immunoassay (ELISA) is employed for this purpose.

More preferably, the mouse having the highest antibody titer is given a third i.v. injection of approximately 25 µg of the same protein or fragment. The splenic leukocytes from this animal may be recovered 3 days later and then permitted to fuse, most preferably, using polyethylene glycol, with cells of a suitable myeloma cell line (such as, for example, the P3X63Ag8.653 myeloma cell line). Hybridoma cells are selected by culturing the cells under "HAT" (hypoxanthine-aminopterin-thymine) selection for about one week. The resulting clones may then be screened for their capacity to produce monoclonal antibodies ("mAbs"), preferably by direct ELISA.

In one embodiment, anti-protein or peptide monoclonal antibodies are isolated using a fusion of a protein or peptide of the present invention, or conjugate of a protein or peptide of the present invention, as immunogens. Thus, for example, a group of mice can be immunized using

a fusion protein emulsified in Freund's complete adjuvant (*e.g.* approximately 50 µg of antigen per immunization). At three week intervals, an identical amount of antigen is emulsified in Freund's incomplete adjuvant and used to immunize the animals. Ten days following the third immunization, serum samples are taken and evaluated for the presence of antibody. If antibody titers are too low, a fourth booster can be employed. Polysera capable of binding the protein or peptide can also be obtained using this method.

In a preferred procedure for obtaining monoclonal antibodies, the spleens of the above-described immunized mice are removed, disrupted and immune splenocytes are isolated over a ficoll gradient. The isolated splenocytes are fused, using polyethylene glycol with BALB/c-derived HGPRT (hypoxanthine guanine phosphoribosyl transferase) deficient P3x63xAg8.653 plasmacytoma cells. The fused cells are plated into 96 well microtiter plates and screened for hybridoma fusion cells by their capacity to grow in culture medium supplemented with hypoxanthine, aminopterin and thymidine for approximately 2-3 weeks.

Hybridoma cells that arise from such incubation are preferably screened for their capacity to produce an immunoglobulin that binds to a protein of interest. An indirect ELISA may be used for this purpose. In brief, the supernatants of hybridomas are incubated in microtiter wells that contain immobilized protein. After washing, the titer of bound immunoglobulin can be determined using, for example, a goat anti-mouse antibody conjugated to horseradish peroxidase. After additional washing, the amount of immobilized enzyme is determined (for example through the use of a chromogenic substrate). Such screening is performed as quickly as possible after the identification of the hybridoma in order to ensure that a desired clone is not overgrown by non-secreting neighbor cells. Desirably, the fusion plates are screened several times since the rates of hybridoma growth vary. In a preferred sub-embodiment, a different antigenic form may

be used to screen the hybridoma. Thus, for example, the splenocytes may be immunized with one immunogen, but the resulting hybridomas can be screened using a different immunogen. It is understood that any of the protein or peptide molecules of the present invention may be used to raise antibodies.

5 As discussed below, such antibody molecules or their fragments may be used for diagnostic purposes. Where the antibodies are intended for diagnostic purposes, it may be desirable to derivatize them, for example with a ligand group (such as biotin) or a detectable marker group (such as a fluorescent group, a radioisotope or an enzyme).

The ability to produce antibodies that bind the protein or peptide molecules of the present invention permits the identification of mimetic compounds of those molecules. A “mimetic compound” is a compound that is not that compound, or a fragment of that compound, but which nonetheless exhibits an ability to specifically bind to antibodies directed against that compound.

It is understood that any of the agents of the present invention can be substantially purified and/or be biologically active and/or recombinant.

Uses of the Agents of the Invention

Nucleic acid molecules and fragments thereof of the present invention may be employed to obtain other nucleic acid molecules from the same species (e.g., ESTs or fragment thereof from maize may be utilized to obtain other nucleic acid molecules from maize). Such nucleic acid molecules include the nucleic acid molecules that encode the complete coding sequence of a
20 protein and promoters and flanking sequences of such molecules. In addition, such nucleic acid molecules include nucleic acid molecules that encode for other isozymes or gene family members. Such molecules can be readily obtained by using the above-described nucleic acid

molecules or fragments thereof to screen cDNA or genomic libraries obtained from maize or soybean. Methods for forming such libraries are well known in the art.

Nucleic acid molecules and fragments thereof of the present invention may also be employed to obtain nucleic acid homologues. Such homologues include the nucleic acid molecule of other plants or other organisms (*e.g.*, alfalfa, *Arabidopsis*, barley, *Brassica*, broccoli, cabbage, citrus, cotton, garlic, oat, oilseed rape, onion, canola, flax, an ornamental plant, pea, peanut, pepper, potato, rice, rye, sorghum, strawberry, sugarcane, sugarbeet, tomato, wheat, poplar, pine, fir, eucalyptus, apple, lettuce, lentils, grape, banana, tea, turf grasses, sunflower, oil palm, *Phaseolus*, etc.) including the nucleic acid molecules that encode, in whole or in part, protein homologues of other plant species or other organisms, sequences of genetic elements such as promoters and transcriptional regulatory elements. Such molecules can be readily obtained by using the above-described nucleic acid molecules or fragments thereof to screen cDNA or genomic libraries obtained from such plant species. Methods for forming such libraries are well known in the art. Such homologue molecules may differ in their nucleotide sequences from those found in one or more of SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof because complete complementarity is not needed for stable hybridization. The nucleic acid molecules of the present invention therefore also include molecules that, although capable of specifically hybridizing with the nucleic acid molecules may lack "complete complementarity."

Any of a variety of methods may be used to obtain one or more of the above-described nucleic acid molecules (Zamechik *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 83:4143-4146 (1986), the entirety of which is herein incorporated by reference; Goodchild *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 85:5507-5511 (1988), the entirety of which is herein incorporated by reference; Wickstrom *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 85:1028-1032 (1988), the entirety of which is

herein incorporated by reference; Holt *et al.*, *Molec. Cell. Biol.* 8:963-973 (1988), the entirety of which is herein incorporated by reference; Gerwitz *et al.*, *Science* 242:1303-1306 (1988), the entirety of which is herein incorporated by reference; Anfossi *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 86:3379-3383 (1989), the entirety of which is herein incorporated by reference; Becker *et al.*, *EMBO J.* 8:3685-3691 (1989); the entirety of which is herein incorporated by reference).

Automated nucleic acid synthesizers may be employed for this purpose. In lieu of such synthesis, the disclosed nucleic acid molecules may be used to define a pair of primers that can be used with the polymerase chain reaction (Mullis *et al.*, *Cold Spring Harbor Symp. Quant. Biol.* 51:263-273 (1986); Erlich *et al.*, European Patent 50,424; European Patent 84,796; European Patent 258,017; European Patent 237,362; Mullis, European Patent 201,184; Mullis *et al.*, U.S. Patent No. 4,683,202; Erlich, U.S. Patent No. 4,582,788; and Saiki *et al.*, U.S. Patent No. 4,683,194, all of which are herein incorporated by reference in their entirety) to amplify and obtain any desired nucleic acid molecule or fragment.

Promoter sequence(s) and other genetic elements, including but not limited to transcriptional regulatory flanking sequences, associated with one or more of the disclosed nucleic acid sequences can also be obtained using the disclosed nucleic acid sequence provided herein. In one embodiment, such sequences are obtained by incubating EST nucleic acid molecules or preferably fragments thereof with members of genomic libraries (*e.g.* maize and soybean) and recovering clones that hybridize to the EST nucleic acid molecule or fragment thereof. In a second embodiment, methods of "chromosome walking," or inverse PCR may be used to obtain such sequences (Frohman *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 85:8998-9002 (1988); Ohara *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 86:5673-5677 (1989); Pang *et al.*, *Biotechniques* 22:1046-1048 (1977); Huang *et al.*, *Methods Mol. Biol.* 69:89-96 (1997); Huang

et al., *Method Mol. Biol.* 67:287-294 (1997); Benkel *et al.*, *Genet. Anal.* 13:123-127 (1996); Hartl *et al.*, *Methods Mol. Biol.* 58:293-301 (1996), all of which are herein incorporated by reference in their entirety).

The nucleic acid molecules of the present invention may be used to isolate promoters of cell enhanced, cell specific, tissue enhanced, tissue specific, developmentally or environmentally regulated expression profiles. Isolation and functional analysis of the 5' flanking promoter sequences of these genes from genomic libraries, for example, using genomic screening methods and PCR techniques would result in the isolation of useful promoters and transcriptional regulatory elements. These methods are known to those of skill in the art and have been described (See, for example, Birren *et al.*, *Genome Analysis: Analyzing DNA*, 1, (1997), Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y., the entirety of which is herein incorporated by reference). Promoters obtained utilizing the nucleic acid molecules of the present invention could also be modified to affect their control characteristics. Examples of such modifications would include but are not limited to enhanced sequences as reported in Uses of the Agents of the Invention, Section (a) Plant Constructs and Plant Transformants. Such genetic elements could be used to enhance gene expression of new and existing traits for crop improvements.

In one sub-aspect, such an analysis is conducted by determining the presence and/or identity of polymorphism(s) by one or more of the nucleic acid molecules of the present invention and more preferably one or more of the EST nucleic acid molecule or fragment thereof which are associated with a phenotype, or a predisposition to that phenotype.

Any of a variety of molecules can be used to identify such polymorphism(s). In one embodiment, one or more of the EST nucleic acid molecules (or a sub-fragment thereof) may be

employed as a marker nucleic acid molecule to identify such polymorphism(s). Alternatively, such polymorphisms can be detected through the use of a marker nucleic acid molecule or a marker protein that is genetically linked to (i.e., a polynucleotide that co-segregates with) such polymorphism(s).

5 In an alternative embodiment, such polymorphisms can be detected through the use of a marker nucleic acid molecule that is physically linked to such polymorphism(s). For this purpose, marker nucleic acid molecules comprising a nucleotide sequence of a polynucleotide located within 1mb of the polymorphism(s) and more preferably within 100kb of the polymorphism(s) and most preferably within 10kb of the polymorphism(s) can be employed.

The genomes of animals and plants naturally undergo spontaneous mutation in the course of their continuing evolution (Gusella, *Ann. Rev. Biochem.* 55:831-854 (1986)). A “polymorphism” is a variation or difference in the sequence of the gene or its flanking regions that arises in some of the members of a species. The variant sequence and the “original” sequence co-exist in the species’ population. In some instances, such co-existence is in stable or quasi-stable equilibrium.

A polymorphism is thus said to be “allelic,” in that, due to the existence of the polymorphism, some members of a species may have the original sequence (i.e., the original “allele”) whereas other members may have the variant sequence (i.e., the variant “allele”). In the simplest case, only one variant sequence may exist and the polymorphism is thus said to be di-
20 allelic. In other cases, the species’ population may contain multiple alleles and the polymorphism is termed tri-allelic, etc. A single gene may have multiple different unrelated polymorphisms. For example, it may have a di-allelic polymorphism at one site and a multi-allelic polymorphism at another site.

al., U.S. Patent No. 4,683,194), using primer pairs that are capable of hybridizing to the proximal sequences that define a polymorphism in its double-stranded form.

In lieu of PCR, alternative methods, such as the "Ligase Chain Reaction" ("LCR") may be used (Barany, *Proc. Natl. Acad. Sci. (U.S.A.)* 88:189-193 (1991), the entirety of which is
5 herein incorporated by reference). LCR uses two pairs of oligonucleotide probes to exponentially amplify a specific target. The sequences of each pair of oligonucleotides is selected to permit the pair to hybridize to abutting sequences of the same strand of the target. Such hybridization forms a substrate for a template-dependent ligase. As with PCR, the resulting products thus serve as a template in subsequent cycles and an exponential amplification of the
10 desired sequence is obtained.

LCR can be performed with oligonucleotides having the proximal and distal sequences of the same strand of a polymorphic site. In one embodiment, either oligonucleotide will be designed to include the actual polymorphic site of the polymorphism. In such an embodiment, the reaction conditions are selected such that the oligonucleotides can be ligated together only if the target molecule either contains or lacks the specific nucleotide that is complementary to the polymorphic site present on the oligonucleotide. Alternatively, the oligonucleotides may be selected such that they do not include the polymorphic site (see, Segev, PCT Application WO
15 90/01069, the entirety of which is herein incorporated by reference).

The "Oligonucleotide Ligation Assay" ("OLA") may alternatively be employed
20 (Landegren *et al.*, *Science* 241:1077-1080 (1988), the entirety of which is herein incorporated by reference). The OLA protocol uses two oligonucleotides which are designed to be capable of hybridizing to abutting sequences of a single strand of a target. OLA, like LCR, is particularly

suited for the detection of point mutations. Unlike LCR, however, OLA results in "linear" rather than exponential amplification of the target sequence.

Nickerson *et al.*, have described a nucleic acid detection assay that combines attributes of PCR and OLA (Nickerson *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 87:8923-8927 (1990), the entirety of which is herein incorporated by reference). In this method, PCR is used to achieve the exponential amplification of target DNA, which is then detected using OLA. In addition to requiring multiple and separate, processing steps, one problem associated with such combinations is that they inherit all of the problems associated with PCR and OLA.

Schemes based on ligation of two (or more) oligonucleotides in the presence of nucleic acid having the sequence of the resulting "di-oligonucleotide", thereby amplifying the di-oligonucleotide, are also known (Wu *et al.*, *Genomics* 4:560-569 (1989), the entirety of which is herein incorporated by reference) and may be readily adapted to the purposes of the present invention.

Other known nucleic acid amplification procedures, such as allele-specific oligomers, branched DNA technology, transcription-based amplification systems, or isothermal amplification methods may also be used to amplify and analyze such polymorphisms (Malek *et al.*, U.S. Patent No. 5,130,238; Davey *et al.*, European Patent Application 329,822; Schuster *et al.*, U.S. Patent No. 5,169,766; Miller *et al.*, PCT Patent Application WO 89/06700; Kwoh *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 86:1173-1177 (1989); Gingeras *et al.*, PCT Patent Application WO 88/10315; Walker *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 89:392-396 (1992), all of which are herein incorporated by reference in their entirety).

The identification of a polymorphism can be determined in a variety of ways. By correlating the presence or absence of it in a plant with the presence or absence of a phenotype, it

is possible to predict the phenotype of that plant. If a polymorphism creates or destroys a restriction endonuclease cleavage site, or if it results in the loss or insertion of DNA (e.g., a VNTR polymorphism), it will alter the size or profile of the DNA fragments that are generated by digestion with that restriction endonuclease. As such, individuals that possess a variant sequence can be distinguished from those having the original sequence by restriction fragment analysis. Polymorphisms that can be identified in this manner are termed "restriction fragment length polymorphisms" ("RFLPs"). RFLPs have been widely used in human and plant genetic analyses (Glassberg, UK Patent Application 2135774; Skolnick *et al.*, *Cytogen. Cell Genet.* 32:58-67 (1982); Botstein *et al.*, *Ann. J. Hum. Genet.* 32:314-331 (1980); Fischer *et al.*, (PCT Application WO90/13668); Uhlen, PCT Application WO90/11369).

Polymorphisms can also be identified by Single Strand Conformation Polymorphism (SSCP) analysis. SSCP is a method capable of identifying most sequence variations in a single strand of DNA, typically between 150 and 250 nucleotides in length (Elles, *Methods in Molecular Medicine: Molecular Diagnosis of Genetic Diseases*, Humana Press (1996), the entirety of which is herein incorporated by reference); Orita *et al.*, *Genomics* 5:874-879 (1989), the entirety of which is herein incorporated by reference). Under denaturing conditions a single strand of DNA will adopt a conformation that is uniquely dependent on its sequence conformation. This conformation usually will be different, even if only a single base is changed. Most conformations have been reported to alter the physical configuration or size sufficiently to be detectable by electrophoresis. A number of protocols have been described for SSCP including, but not limited to, Lee *et al.*, *Anal. Biochem.* 205:289-293 (1992), the entirety of which is herein incorporated by reference; Suzuki *et al.*, *Anal. Biochem.* 192:82-84 (1991), the entirety of which is herein incorporated by reference; Lo *et al.*, *Nucleic Acids Research* 20:1005-

1009 (1992), the entirety of which is herein incorporated by reference; Sarkar *et al.*, *Genomics* 13:441-443 (1992), the entirety of which is herein incorporated by reference. It is understood that one or more of the nucleic acids of the present invention, may be utilized as markers or probes to detect polymorphisms by SSCP analysis.

5 Polymorphisms may also be found using a DNA fingerprinting technique called amplified fragment length polymorphism (AFLP), which is based on the selective PCR amplification of restriction fragments from a total digest of genomic DNA to profile that DNA (Vos *et al.*, *Nucleic Acids Res.* 23:4407-4414 (1995), the entirety of which is herein incorporated by reference). This method allows for the specific co-amplification of high numbers of restriction fragments, which can be visualized by PCR without knowledge of the nucleic acid sequence.

AFLP employs basically three steps. Initially, a sample of genomic DNA is cut with restriction enzymes and oligonucleotide adapters are ligated to the restriction fragments of the DNA. The restriction fragments are then amplified using PCR by using the adapter and restriction sequence as target sites for primer annealing. The selective amplification is achieved by the use of primers that extend into the restriction fragments, amplifying only those fragments in which the primer extensions match the nucleotide flanking the restriction sites. These amplified fragments are then visualized on a denaturing polyacrylamide gel.

AFLP analysis has been performed on *Salix* (Beismann *et al.*, *Mol. Ecol.* 6:989-993 (1997), the entirety of which is herein incorporated by reference), *Acinetobacter* (Janssen *et al.*, *Int. J. Syst. Bacteriol.* 47:1179-1187 (1997), the entirety of which is herein incorporated by reference), *Aeromonas popoffi* (Huys *et al.*, *Int. J. Syst. Bacteriol.* 47:1165-1171 (1997), the entirety of which is herein incorporated by reference), rice (McCouch *et al.*, *Plant Mol. Biol.*

35:89-99 (1997), the entirety of which is herein incorporated by reference; Nandi *et al.*, *Mol. Gen. Genet.* 255:1-8 (1997), the entirety of which is herein incorporated by reference; Cho *et al.*, *Genome* 39:373-378 (1996), the entirety of which is herein incorporated by reference), barley (*Hordeum vulgare*)(Simons *et al.*, *Genomics* 44:61-70 (1997), the entirety of which is herein incorporated by reference; Waugh *et al.*, *Mol. Gen. Genet.* 255:311-321 (1997), the entirety of which is herein incorporated by reference; Qi *et al.*, *Mol. Gen. Genet.* 254:330-336 (1997), the entirety of which is herein incorporated by reference; Becker *et al.*, *Mol. Gen. Genet.* 249:65-73 (1995), the entirety of which is herein incorporated by reference), potato (Van der Voort *et al.*, *Mol. Gen. Genet.* 255:438-447 (1997), the entirety of which is herein incorporated by reference; Meksem *et al.*, *Mol. Gen. Genet.* 249:74-81 (1995), the entirety of which is herein incorporated by reference), *Phytophthora infestans* (Van der Lee *et al.*, *Fungal Genet. Biol.* 21:278-291 (1997), the entirety of which is herein incorporated by reference), *Bacillus anthracis* (Keim *et al.*, *J. Bacteriol.* 179:818-824 (1997), the entirety of which is herein incorporated by reference), *Astragalus cremnophylax* (Travis *et al.*, *Mol. Ecol.* 5:735-745 (1996), the entirety of which is herein incorporated by reference), *Arabidopsis* (Cnops *et al.*, *Mol. Gen. Genet.* 253:32-41 (1996), the entirety of which is herein incorporated by reference), *Escherichia coli* (Lin *et al.*, *Nucleic Acids Res.* 24:3649-3650 (1996), the entirety of which is herein incorporated by reference), *Aeromonas* (Huys *et al.*, *Int. J. Syst. Bacteriol.* 46:572-580 (1996), the entirety of which is herein incorporated by reference), nematode (Folkertsma *et al.*, *Mol. Plant Microbe Interact.* 9:47-54 (1996), the entirety of which is herein incorporated by reference), tomato (Thomas *et al.*, *Plant J.* 8:785-794 (1995), the entirety of which is herein incorporated by reference) and human (Latorra *et al.*, *PCR Methods Appl.* 3:351-358 (1994), the entirety of which is herein incorporated by reference). AFLP analysis has also been used for fingerprinting mRNA (Money *et al.*, *Nucleic*

Acids Res. 24:2616-2617 (1996), the entirety of which is herein incorporated by reference; Bachem *et al.*, *Plant J.* 9:745-753 (1996), the entirety of which is herein incorporated by reference). It is understood that one or more of the nucleic acids of the present invention, may be utilized as markers or probes to detect polymorphisms by AFLP analysis or for fingerprinting RNA.

Polymorphisms may also be found using random amplified polymorphic DNA (RAPD) (Williams *et al.*, *Nucl. Acids Res.* 18:6531-6535 (1990), the entirety of which is herein incorporated by reference) and cleaveable amplified polymorphic sequences (CAPS) (Lyamichev *et al.*, *Science* 260:778-783 (1993), the entirety of which is herein incorporated by reference). It is understood that one or more of the nucleic acid molecules of the present invention, may be utilized as markers or probes to detect polymorphisms by RAPD or CAPS analysis.

Through genetic mapping, a fine scale linkage map can be developed using DNA markers and, then, a genomic DNA library of large-sized fragments can be screened with molecular markers linked to the desired trait. Molecular markers are advantageous for agronomic traits that are otherwise difficult to tag, such as resistance to pathogens, insects and nematodes, tolerance to abiotic stress, quality parameters and quantitative traits such as high yield potential.

The essential requirements for marker-assisted selection in a plant breeding program are: (1) the marker(s) should co-segregate or be closely linked with the desired trait; (2) an efficient means of screening large populations for the molecular marker(s) should be available; and (3) the screening technique should have high reproducibility across laboratories and preferably be economical to use and be user-friendly.

The genetic linkage of marker molecules can be established by a gene mapping model such as, without limitation, the flanking marker model reported by Lander and Botstein, *Genetics*

121:185-199 (1989) and the interval mapping, based on maximum likelihood methods described by Lander and Botstein, *Genetics* 121:185-199 (1989) and implemented in the software package MAPMAKER/QTL (Lincoln and Lander, *Mapping Genes Controlling Quantitative Traits Using MAPMAKER/QTL*, Whitehead Institute for Biomedical Research, Massachusetts, (1990).

- 5 Additional software includes Qgene, Version 2.23 (1996), Department of Plant Breeding and Biometry, 266 Emerson Hall, Cornell University, Ithaca, NY, the manual of which is herein incorporated by reference in its entirety). Use of Qgene software is a particularly preferred approach.

A maximum likelihood estimate (MLE) for the presence of a marker is calculated, together with an MLE assuming no QTL effect, to avoid false positives. A \log_{10} of an odds ratio (LOD) is then calculated as: $\text{LOD} = \log_{10}(\text{MLE for the presence of a QTL} / \text{MLE given no linked QTL})$.

The LOD score essentially indicates how much more likely the data are to have arisen assuming the presence of a QTL than in its absence. The LOD threshold value for avoiding a false positive with a given confidence, say 95%, depends on the number of markers and the length of the genome. Graphs indicating LOD thresholds are set forth in Lander and Botstein, *Genetics* 121:185-199 (1989) the entirety of which is herein incorporated by reference and further described by Arús and Moreno-González, *Plant Breeding*, Hayward *et al.*, (eds.) Chapman & Hall, London, pp. 314-331 (1993), the entirety of which is herein incorporated by
20 reference.

Additional models can be used. Many modifications and alternative approaches to interval mapping have been reported, including the use non-parametric methods (Kruglyak and Lander, *Genetics* 139:1421-1428 (1995), the entirety of which is herein incorporated by

reference). Multiple regression methods or models can be also be used, in which the trait is regressed on a large number of markers (Jansen, *Biometrics in Plant Breeding*, van Oijen and Jansen (eds.), Proceedings of the Ninth Meeting of the Eucarpia Section Biometrics in Plant Breeding, The Netherlands, pp. 116-124 (1994); Weber and Wricke, *Advances in Plant Breeding*, Blackwell, Berlin, 16 (1994), both of which is herein incorporated by reference in their entirety).

Procedures combining interval mapping with regression analysis, whereby the phenotype is regressed onto a single putative QTL at a given marker interval and at the same time onto a number of markers that serve as 'cofactors,' have been reported by Jansen and Stam, *Genetics* 136:1447-1455 (1994), the entirety of which is herein incorporated by reference and Zeng, *Genetics* 136:1457-1468 (1994) the entirety of which is herein incorporated by reference. Generally, the use of cofactors reduces the bias and sampling error of the estimated QTL positions (Utz and Melchinger, *Biometrics in Plant Breeding*, van Oijen and Jansen (eds.) Proceedings of the Ninth Meeting of the Eucarpia Section Biometrics in Plant Breeding, The Netherlands, pp.195-204 (1994), the entirety of which is herein incorporated by reference, thereby improving the precision and efficiency of QTL mapping (Zeng, *Genetics* 136:1457-1468 (1994)). These models can be extended to multi-environment experiments to analyze genotype-environment interactions (Jansen *et al.*, *Theo. Appl. Genet.* 91:33-37 (1995), the entirety of which is herein incorporated by reference).

Selection of an appropriate mapping populations is important to map construction. The choice of appropriate mapping population depends on the type of marker systems employed (Tanksley *et al.*, *Molecular mapping plant chromosomes. Chromosome structure and function: Impact of new concepts*, Gustafson and Appels (eds.), Plenum Press, New York, pp 157-173 (1988), the entirety of which is herein incorporated by reference). Consideration must be given

to the source of parents (adapted vs. exotic) used in the mapping population. Chromosome pairing and recombination rates can be severely disturbed (suppressed) in wide crosses (adapted x exotic) and generally yield greatly reduced linkage distances. Wide crosses will usually provide segregating populations with a relatively large array of polymorphisms when compared to progeny in a narrow cross (adapted x adapted).

An F_2 population is the first generation of selfing after the hybrid seed is produced. Usually a single F_1 plant is selfed to generate a population segregating for all the genes in Mendelian (1:2:1) fashion. Maximum genetic information is obtained from a completely classified F_2 population using a codominant marker system (Mather, *Measurement of Linkage in Heredity*, Methuen and Co., (1938), the entirety of which is herein incorporated by reference). In the case of dominant markers, progeny tests (e.g. F_3 , BCF_2) are required to identify the heterozygotes, thus making it equivalent to a completely classified F_2 population. However, this procedure is often prohibitive because of the cost and time involved in progeny testing. Progeny testing of F_2 individuals is often used in map construction where phenotypes do not consistently reflect genotype (e.g. disease resistance) or where trait expression is controlled by a QTL. Segregation data from progeny test populations (e.g. F_3 or BCF_2) can be used in map construction. Marker-assisted selection can then be applied to cross progeny based on marker-trait map associations (F_2 , F_3), where linkage groups have not been completely disassociated by recombination events (i.e., maximum disequilibrium).

Recombinant inbred lines (RIL) (genetically related lines; usually $>F_5$, developed from continuously selfing F_2 lines towards homozygosity) can be used as a mapping population. Information obtained from dominant markers can be maximized by using RIL because all loci are homozygous or nearly so. Under conditions of tight linkage (i.e., about $<10\%$

recombination), dominant and co-dominant markers evaluated in RIL populations provide more information per individual than either marker type in backcross populations (Reiter *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 89:1477-1481 (1992), the entirety of which is herein incorporated by reference). However, as the distance between markers becomes larger (i.e., loci become more independent), the information in RIL populations decreases dramatically when compared to codominant markers.

Backcross populations (e.g., generated from a cross between a successful variety (recurrent parent) and another variety (donor parent) carrying a trait not present in the former) can be utilized as a mapping population. A series of backcrosses to the recurrent parent can be made to recover most of its desirable traits. Thus a population is created consisting of individuals nearly like the recurrent parent but each individual carries varying amounts or mosaic of genomic regions from the donor parent. Backcross populations can be useful for mapping dominant markers if all loci in the recurrent parent are homozygous and the donor and recurrent parent have contrasting polymorphic marker alleles (Reiter *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 89:1477-1481 (1992)). Information obtained from backcross populations using either codominant or dominant markers is less than that obtained from F_2 populations because one, rather than two, recombinant gametes are sampled per plant. Backcross populations, however, are more informative (at low marker saturation) when compared to RILs as the distance between linked loci increases in RIL populations (i.e. about 15% recombination). Increased recombination can be beneficial for resolution of tight linkages, but may be undesirable in the construction of maps with low marker saturation.

Near-isogenic lines (NIL) created by many backcrosses to produce an array of individuals that are nearly identical in genetic composition except for the trait or genomic region under

interrogation can be used as a mapping population. In mapping with NILs, only a portion of the polymorphic loci are expected to map to a selected region.

Bulk segregant analysis (BSA) is a method developed for the rapid identification of linkage between markers and traits of interest (Michelmore *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 88:9828-9832 (1991), the entirety of which is herein incorporated by reference). In BSA, two bulked DNA samples are drawn from a segregating population originating from a single cross. These bulks contain individuals that are identical for a particular trait (resistant or susceptible to particular disease) or genomic region but arbitrary at unlinked regions (i.e. heterozygous). Regions unlinked to the target region will not differ between the bulked samples of many individuals in BSA.

It is understood that one or more of the nucleic acid molecules of the present invention may be used as molecular markers. It is also understood that one or more of the protein molecules of the present invention may be used as molecular markers.

In accordance with this aspect of the present invention, a sample nucleic acid is obtained from plants cells or tissues. Any source of nucleic acid may be used. Preferably, the nucleic acid is genomic DNA. The nucleic acid is subjected to restriction endonuclease digestion. For example, one or more nucleic acid molecule or fragment thereof of the present invention can be used as a probe in accordance with the above-described polymorphic methods. The polymorphism obtained in this approach can then be cloned to identify the mutation at the coding region which alters the protein's structure or regulatory region of the gene which affects its expression level.

In an aspect of the present invention, one or more of the nucleic molecules of the present invention are used to determine the level (i.e., the concentration of mRNA in a sample, etc.) in a

plant (preferably maize or soybean) or pattern (i.e., the kinetics of expression, rate of decomposition, stability profile, etc.) of the expression of a protein encoded in part or whole by one or more of the nucleic acid molecule of the present invention (collectively, the “Expression Response” of a cell or tissue). As used herein, the Expression Response manifested by a cell or tissue is said to be “altered” if it differs from the Expression Response of cells or tissues of plants not exhibiting the phenotype. To determine whether an Expression Response is altered, the Expression Response manifested by the cell or tissue of the plant exhibiting the phenotype is compared with that of a similar cell or tissue sample of a plant not exhibiting the phenotype. As will be appreciated, it is not necessary to re-determine the Expression Response of the cell or tissue sample of plants not exhibiting the phenotype each time such a comparison is made; rather, the Expression Response of a particular plant may be compared with previously obtained values of normal plants. As used herein, the phenotype of the organism is any of one or more characteristics of an organism (e.g. disease resistance, pest tolerance, environmental tolerance such as tolerance to abiotic stress, male sterility, quality improvement or yield etc.). A change in genotype or phenotype may be transient or permanent. Also as used herein, a tissue sample is any sample that comprises more than one cell. In a preferred aspect, a tissue sample comprises cells that share a common characteristic (e.g. derived from root, seed, flower, leaf, stem or pollen etc.).

In one aspect of the present invention, an evaluation can be conducted to determine whether a particular mRNA molecule is present. One or more of the nucleic acid molecules of the present invention, preferably one or more of the EST nucleic acid molecules or fragments thereof of the present invention are utilized to detect the presence or quantity of the mRNA species. Such molecules are then incubated with cell or tissue extracts of a plant under

conditions sufficient to permit nucleic acid hybridization. The detection of double-stranded probe-mRNA hybrid molecules is indicative of the presence of the mRNA; the amount of such hybrid formed is proportional to the amount of mRNA. Thus, such probes may be used to ascertain the level and extent of the mRNA production in a plant's cells or tissues. Such nucleic acid hybridization may be conducted under quantitative conditions (thereby providing a numerical value of the amount of the mRNA present). Alternatively, the assay may be conducted as a qualitative assay that indicates either that the mRNA is present, or that its level exceeds a user set, predefined value.

A principle of *in situ* hybridization is that a labeled, single-stranded nucleic acid probe will hybridize to a complementary strand of cellular DNA or RNA and, under the appropriate conditions, these molecules will form a stable hybrid. When nucleic acid hybridization is combined with histological techniques, specific DNA or RNA sequences can be identified within a single cell. An advantage of *in situ* hybridization over more conventional techniques for the detection of nucleic acids is that it allows an investigator to determine the precise spatial population (Angerer *et al.*, *Dev. Biol.* 101:477-484 (1984), the entirety of which is herein incorporated by reference; Angerer *et al.*, *Dev. Biol.* 112:157-166 (1985), the entirety of which is herein incorporated by reference; Dixon *et al.*, *EMBO J.* 10:1317-1324 (1991), the entirety of which is herein incorporated by reference). *In situ* hybridization may be used to measure the steady-state level of RNA accumulation. It is a sensitive technique and RNA sequences present in as few as 5-10 copies per cell can be detected (Hardin *et al.*, *J. Mol. Biol.* 202:417-431 (1989), the entirety of which is herein incorporated by reference). A number of protocols have been devised for *in situ* hybridization, each with tissue preparation, hybridization and washing conditions (Meyerowitz, *Plant Mol. Biol. Rep.* 5:242-250 (1987), the entirety of which is herein

incorporated by reference; Cox and Goldberg, In: *Plant Molecular Biology: A Practical Approach*, Shaw (ed.), pp 1-35, IRL Press, Oxford (1988), the entirety of which is herein incorporated by reference; Raikhel *et al.*, *In situ RNA hybridization in plant tissues*, In: *Plant Molecular Biology Manual*, vol. B9:1-32, Kluwer Academic Publisher, Dordrecht, Belgium
 5 (1989), the entirety of which is herein incorporated by reference).

In situ hybridization also allows for the localization of proteins within a tissue or cell (Wilkinson, *In Situ Hybridization*, Oxford University Press, Oxford (1992), the entirety of which is herein incorporated by reference; Langdale, *In Situ Hybridization In: The Maize Handbook*, Freeling and Walbot (eds.), pp 165-179, Springer-Verlag, New York (1994), the entirety of which is herein incorporated by reference). It is understood that one or more of the molecules of the present invention, preferably one or more of the EST nucleic acid molecules or fragments thereof of the present invention or one or more of the antibodies of the present invention may be utilized to detect the level or pattern of a tocopherol synthesis pathway enzyme or mRNA thereof by *in situ* hybridization.

Fluorescent *in situ* hybridization allows the localization of a particular DNA sequence along a chromosome which is useful, among other uses, for gene mapping, following chromosomes in hybrid lines or detecting chromosomes with translocations, transversions or deletions. *In situ* hybridization has been used to identify chromosomes in several plant species (Griffor *et al.*, *Plant Mol. Biol.* 17:101-109 (1991), the entirety of which is herein incorporated
 20 by reference; Gustafson *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 87:1899-1902 (1990), herein incorporated by reference; Mukai and Gill, *Genome* 34:448-452 (1991), the entirety of which is herein incorporated by reference; Schwarzacher and Heslop-Harrison, *Genome* 34:317-323 (1991); Wang *et al.*, *Jpn. J. Genet.* 66:313-316 (1991), the entirety of which is herein

which is herein incorporated by reference) the histochemical localization of various plant enzymes and deoxyribonuclease on nitrocellulose paper and nylon (Spruce *et al.*, *Phytochemistry* 26:2901-2903 (1987), the entirety of which is herein incorporated by reference; Barres *et al.*, *Neuron* 5:527-544 (1990), the entirety of which is herein incorporated by reference; Reid and Pont-Lezica, *Tissue Printing: Tools for the Study of Anatomy, Histochemistry and Gene Expression*, Academic Press, New York, New York (1992), the entirety of which is herein incorporated by reference; Reid *et al.*, *Plant Physiol.* 93:160-165 (1990), the entirety of which is herein incorporated by reference; Ye *et al.*, *Plant J.* 1:175-183 (1991), the entirety of which is herein incorporated by reference).

It is understood that one or more of the molecules of the present invention, preferably one or more of the EST nucleic acid molecules or fragments thereof of the present invention or one or more of the antibodies of the present invention may be utilized to detect the presence or quantity of a tocopherol synthesis pathway enzyme by tissue printing.

Further it is also understood that any of the nucleic acid molecules of the present invention may be used as marker nucleic acids and or probes in connection with methods that require probes or marker nucleic acids. As used herein, a probe is an agent that is utilized to determine an attribute or feature (e.g. presence or absence, location, correlation, etc.) of a molecule, cell, tissue or plant. As used herein, a marker nucleic acid is a nucleic acid molecule that is utilized to determine an attribute or feature (e.g., presence or absence, location, correlation, etc.) or a molecule, cell, tissue or plant.

A microarray-based method for high-throughput monitoring of plant gene expression may be utilized to measure gene-specific hybridization targets. This 'chip'-based approach involves using microarrays of nucleic acid molecules as gene-specific hybridization targets to

quantitatively measure expression of the corresponding plant genes (Schena *et al.*, *Science* 270:467-470 (1995), the entirety of which is herein incorporated by reference; Shalon, Ph.D. Thesis, Stanford University (1996), the entirety of which is herein incorporated by reference). Every nucleotide in a large sequence can be queried at the same time. Hybridization can be used to efficiently analyze nucleotide sequences.

Several microarray methods have been described. One method compares the sequences to be analyzed by hybridization to a set of oligonucleotides representing all possible subsequences (Bains and Smith, *J. Theor. Biol.* 135:303-307 (1989), the entirety of which is herein incorporated by reference). A second method hybridizes the sample to an array of oligonucleotide or cDNA molecules. An array consisting of oligonucleotides complementary to subsequences of a target sequence can be used to determine the identity of a target sequence, measure its amount and detect differences between the target and a reference sequence. Nucleic acid molecule microarrays may also be screened with protein molecules or fragments thereof to determine nucleic acid molecules that specifically bind protein molecules or fragments thereof.

The microarray approach may be used with polypeptide targets (U.S. Patent No. 5,445,934; U.S. Patent No. 5,143,854; U.S. Patent No. 5,079,600; U.S. Patent No. 4,923,901, all of which are herein incorporated by reference in their entirety). Essentially, polypeptides are synthesized on a substrate (microarray) and these polypeptides can be screened with either protein molecules or fragments thereof or nucleic acid molecules in order to screen for either protein molecules or fragments thereof or nucleic acid molecules that specifically bind the target polypeptides. (Fodor *et al.*, *Science* 251:767-773 (1991), the entirety of which is herein incorporated by reference). It is understood that one or more of the nucleic acid molecules or

protein or fragments thereof of the present invention may be utilized in a microarray based method.

In a preferred embodiment of the present invention microarrays may be prepared that comprise nucleic acid molecules where such nucleic acid molecules encode at least one, preferably at least two, more preferably at least three tocopherol synthesis pathway enzymes, more preferably at least four tocopherol synthesis pathway enzymes, more preferably at least five tocopherol synthesis pathway enzymes, more preferably at least six tocopherol synthesis pathway enzymes, more preferably at least seven tocopherol synthesis pathway enzymes, more preferably at least eight tocopherol synthesis pathway enzymes, more preferably at least nine tocopherol synthesis pathway enzymes, more preferably at least ten tocopherol synthesis pathway enzymes, more preferably at least eleven tocopherol synthesis pathway enzymes, more preferably at least twelve tocopherol synthesis pathway enzymes, more preferably at least thirteen tocopherol synthesis pathway enzymes, more preferably at least fourteen tocopherol synthesis pathway enzymes, more preferably at least fifteen tocopherol synthesis pathway enzymes, more preferably at least sixteen tocopherol synthesis pathway enzymes, and even more preferably at least seventeen tocopherol synthesis pathway enzymes. In a preferred embodiment the nucleic acid molecules are selected from the group consisting of a nucleic acid molecule that encodes a maize or soybean deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean putative deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize dehydroquinase synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a soybean dehydroquinase dehydratase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize putative dehydroquinase dehydratase enzyme or fragment thereof; a nucleic acid molecule

that encodes a maize or soybean shikimate dehydrogenase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean shikimate kinase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize enolpyruvylshikimate-P-synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean chorismate synthase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean chorismate mutase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize tyrosine transaminase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean putative tyrosine transaminase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean transaminase A enzyme or fragment thereof; a nucleic acid molecule that encodes a soybean putative transaminase A enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean 4-hydroxyphenylpyruvate dioxygenase enzyme or fragment thereof; a nucleic acid molecule that encodes a maize or soybean homogentisic acid dioxygenase enzyme or fragment thereof; and a nucleic acid molecule that encodes a maize or soybean geranylgeranylpyrophosphate synthase enzyme or fragment thereof.

Site directed mutagenesis may be utilized to modify nucleic acid sequences, particularly as it is a technique that allows one or more of the amino acids encoded by a nucleic acid molecule to be altered (e.g. a threonine to be replaced by a methionine). Three basic methods for site directed mutagenesis are often employed. These are cassette mutagenesis (Wells *et al.*, *Gene* 34:315-323 (1985), the entirety of which is herein incorporated by reference), primer extension (Gilliam *et al.*, *Gene* 12:129-137 (1980), the entirety of which is herein incorporated by reference; Zoller and Smith, *Methods Enzymol.* 100:468-500 (1983), the entirety of which is herein incorporated by reference; Dalbadie-McFarland *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 79:6409-6413 (1982), the entirety of which is herein incorporated by reference) and methods

based upon PCR (Scharf *et al.*, *Science* 233:1076-1078 (1986), the entirety of which is herein incorporated by reference; Higuchi *et al.*, *Nucleic Acids Res.* 16:7351-7367 (1988), the entirety of which is herein incorporated by reference). Site directed mutagenesis approaches are also described in European Patent 0 385 962, the entirety of which is herein incorporated by reference; European Patent 0 359 472, the entirety of which is herein incorporated by reference; and PCT Patent Application WO 93/07278, the entirety of which is herein incorporated by reference.

Site directed mutagenesis strategies have been applied to plants for both *in vitro* as well as *in vivo* site directed mutagenesis (Lanz *et al.*, *J. Biol. Chem.* 266:9971-9976 (1991), the entirety of which is herein incorporated by reference; Kovgan and Zhdanov, *Biotechnologiya* 5:148-154; No. 207160n, Chemical Abstracts 110:225 (1989), the entirety of which is herein incorporated by reference; Ge *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 86:4037-4041 (1989), the entirety of which is herein incorporated by reference; Zhu *et al.*, *J. Biol. Chem.* 271:18494-18498 (1996), the entirety of which is herein incorporated by reference; Chu *et al.*, *Biochemistry* 33:6150-6157 (1994), the entirety of which is herein incorporated by reference; Small *et al.*, *EMBO J.* 11:1291-1296 (1992), the entirety of which is herein incorporated by reference; Cho *et al.*, *Mol. Biotechnol.* 8:13-16 (1997), the entirety of which is herein incorporated by reference; Kita *et al.*, *J. Biol. Chem.* 271:26529-26535 (1996), the entirety of which is herein incorporated by reference; Jin *et al.*, *Mol. Microbiol.* 7:555-562 (1993), the entirety of which is herein incorporated by reference; Hatfield and Vierstra, *J. Biol. Chem.* 267:14799-14803 (1992), the entirety of which is herein incorporated by reference; Zhao *et al.*, *Biochemistry* 31:5093-5099 (1992), the entirety of which is herein incorporated by reference).

Any of the nucleic acid molecules of the present invention may either be modified by site directed mutagenesis or used as, for example, nucleic acid molecules that are used to target other nucleic acid molecules for modification. It is understood that mutants with more than one altered nucleotide can be constructed using techniques that practitioners are familiar with such as isolating restriction fragments and ligating such fragments into an expression vector (*see, for example, Sambrook et al., Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Press (1989).*)

Sequence-specific DNA-binding proteins play a role in the regulation of transcription. The isolation of recombinant cDNAs encoding these proteins facilitates the biochemical analysis of their structural and functional properties. Genes encoding such DNA-binding proteins have been isolated using classical genetics (Vollbrecht *et al.*, *Nature* 350: 241-243 (1991), the entirety of which is herein incorporated by reference) and molecular biochemical approaches, including the screening of recombinant cDNA libraries with antibodies (Landschulz *et al.*, *Genes Dev.* 2:786-800 (1988), the entirety of which is herein incorporated by reference) or DNA probes (Bodner *et al.*, *Cell* 55:505-518 (1988), the entirety of which is herein incorporated by reference). In addition, an *in situ* screening procedure has been used and has facilitated the isolation of sequence-specific DNA-binding proteins from various plant species (Gilmartin *et al.*, *Plant Cell* 4:839-849 (1992), the entirety of which is herein incorporated by reference; Schindler *et al.*, *EMBO J.* 11:1261-1273 (1992), the entirety of which is herein incorporated by reference). An *in situ* screening protocol does not require the purification of the protein of interest (Vinson *et al.*, *Genes Dev.* 2:801-806 (1988), the entirety of which is herein incorporated by reference; Singh *et al.*, *Cell* 52:415-423 (1988), the entirety of which is herein incorporated by reference).

Two steps may be employed to characterize DNA-protein interactions. The first is to identify promoter fragments that interact with DNA-binding proteins, to titrate binding activity, to determine the specificity of binding and to determine whether a given DNA-binding activity can interact with related DNA sequences (Sambrook *et al.*, *Molecular Cloning: A Laboratory Manual*, 2nd edition, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York (1989)). Electrophoretic mobility-shift assay is a widely used assay. The assay provides a rapid and sensitive method for detecting DNA-binding proteins based on the observation that the mobility of a DNA fragment through a nondenaturing, low-ionic strength polyacrylamide gel is retarded upon association with a DNA-binding protein (Fried and Crother, *Nucleic Acids Res.* 9:6505-6525 (1981), the entirety of which is herein incorporated by reference). When one or more specific binding activities have been identified, the exact sequence of the DNA bound by the protein may be determined. Several procedures for characterizing protein/DNA-binding sites are used, including methylation and ethylation interference assays (Maxam and Gilbert, *Methods Enzymol.* 65:499-560 (1980), the entirety of which is herein incorporated by reference; Wissman and Hillen, *Methods Enzymol.* 208:365-379 (1991), the entirety of which is herein incorporated by reference), footprinting techniques employing DNase I (Galas and Schmitz, *Nucleic Acids Res.* 5:3157-3170 (1978), the entirety of which is herein incorporated by reference), 1,10-phenanthroline-copper ion methods (Sigman *et al.*, *Methods Enzymol.* 208:414-433 (1991), the entirety of which is herein incorporated by reference) and hydroxyl radicals methods (Dixon *et al.*, *Methods Enzymol.* 208:414-433 (1991), the entirety of which is herein incorporated by reference). It is understood that one or more of the nucleic acid molecules of the present invention may be utilized to identify a protein or fragment thereof that specifically binds to a

nucleic acid molecule of the present invention. It is also understood that one or more of the protein molecules or fragments thereof of the present invention may be utilized to identify a nucleic acid molecule that specifically binds to it.

A two-hybrid system is based on the fact that many cellular functions are carried out by proteins, such as transcription factors, that interact (physically) with one another. Two-hybrid systems have been used to probe the function of new proteins (Chien *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 88:9578-9582 (1991) the entirety of which is herein incorporated by reference; Durfee *et al.*, *Genes Dev.* 7:555-569 (1993) the entirety of which is herein incorporated by reference; Choi *et al.*, *Cell* 78:499-512 (1994), the entirety of which is herein incorporated by reference; Kranz *et al.*, *Genes Dev.* 8:313-327 (1994), the entirety of which is herein incorporated by reference).

Interaction mating techniques have facilitated a number of two-hybrid studies of protein-protein interaction. Interaction mating has been used to examine interactions between small sets of tens of proteins (Finley and Brent, *Proc. Natl. Acad. Sci. (U.S.A.)* 91:12098-12984 (1994), the entirety of which is herein incorporated by reference), larger sets of hundreds of proteins (Bendixen *et al.*, *Nucl. Acids Res.* 22:1778-1779 (1994), the entirety of which is herein incorporated by reference) and to comprehensively map proteins encoded by a small genome (Bartel *et al.*, *Nature Genetics* 12:72-77 (1996), the entirety of which is herein incorporated by reference). This technique utilizes proteins fused to the DNA-binding domain and proteins fused to the activation domain. They are expressed in two different haploid yeast strains of opposite mating type and the strains are mated to determine if the two proteins interact. Mating occurs when haploid yeast strains come into contact and result in the fusion of the two haploids into a diploid yeast strain. An interaction can be determined by the activation of a two-hybrid reporter gene in the diploid strain. An advantage of this technique is that it reduces the number of yeast

transformations needed to test individual interactions. It is understood that the protein-protein interactions of protein or fragments thereof of the present invention may be investigated using the two-hybrid system and that any of the nucleic acid molecules of the present invention that encode such proteins or fragments thereof may be used to transform yeast in the two-hybrid system.

(a) Plant Constructs and Plant Transformants

One or more of the nucleic acid molecules of the present invention may be used in plant transformation or transfection. Exogenous genetic material may be transferred into a plant cell and the plant cell regenerated into a whole, fertile or sterile plant. Exogenous genetic material is any genetic material, whether naturally occurring or otherwise, from any source that is capable of being inserted into any organism. Such genetic material may be transferred into either monocotyledons and dicotyledons including, but not limited to maize (pp 63-69), soybean (pp 50-60), *Arabidopsis* (p 45), phaseolus (pp 47-49), peanut (pp 49-50), alfalfa (p 60), wheat (pp 69-71), rice (pp 72-79), oat (pp 80-81), sorghum (p 83), rye (p 84), tritordeum (p 84), millet (p85), fescue (p 85), perennial ryegrass (p 86), sugarcane (p87), cranberry (p101), papaya (pp 101-102), banana (p 103), banana (p 103), muskmelon (p 104), apple (p 104), cucumber (p 105), dendrobium (p 109), gladiolus (p 110), chrysanthemum (p 110), liliacea (p 111), cotton (pp113-114), eucalyptus (p 115), sunflower (p 118), canola (p 118), turfgrass (p121), sugarbeet (p 122), coffee (p 122) and dioscorea (p 122) (Christou, In: *Particle Bombardment for Genetic Engineering of Plants*, Biotechnology Intelligence Unit. Academic Press, San Diego, California (1996), the entirety of which is herein incorporated by reference).

Transfer of a nucleic acid that encodes for a protein can result in overexpression of that protein in a transformed cell or transgenic plant. One or more of the proteins or fragments

thereof encoded by nucleic acid molecules of the present invention may be overexpressed in a transformed cell or transformed plant. Particularly, any of the tocopherol synthesis pathway enzymes or fragments thereof may be overexpressed in a transformed cell or transgenic plant. Such overexpression may be the result of transient or stable transfer of the exogenous genetic material.

Exogenous genetic material may be transferred into a plant cell and the plant cell by the use of a DNA vector or construct designed for such a purpose. Design of such a vector is generally within the skill of the art (*See, Plant Molecular Biology: A Laboratory Manual*, Clark (ed.), Springer, New York (1997), the entirety of which is herein incorporated by reference).

A construct or vector may include a plant promoter to express the protein or protein fragment of choice. A number of promoters which are active in plant cells have been described in the literature. These include the nopaline synthase (NOS) promoter (Ebert *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 84:5745-5749 (1987), the entirety of which is herein incorporated by reference), the octopine synthase (OCS) promoter (which are carried on tumor-inducing plasmids of *Agrobacterium tumefaciens*), the caulimovirus promoters such as the cauliflower mosaic virus (CaMV) 19S promoter (Lawton *et al.*, *Plant Mol. Biol.* 9:315-324 (1987), the entirety of which is herein incorporated by reference) and the CAMV 35S promoter (Odell *et al.*, *Nature* 313:810-812 (1985), the entirety of which is herein incorporated by reference), the figwort mosaic virus 35S-promoter, the light-inducible promoter from the small subunit of ribulose-1,5-bis-phosphate carboxylase (ssRUBISCO), the Adh promoter (Walker *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 84:6624-6628 (1987), the entirety of which is herein incorporated by reference), the sucrose synthase promoter (Yang *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 87:4144-4148 (1990), the entirety of which is herein incorporated by reference), the R gene complex promoter (Chandler *et al.*, *The*

Plant Cell 1:1175-1183 (1989), the entirety of which is herein incorporated by reference) and the chlorophyll a/b binding protein gene promoter, etc. These promoters have been used to create DNA constructs which have been expressed in plants; *see, e.g.*, PCT publication WO 84/02913, herein incorporated by reference in its entirety.

5 Promoters which are known or are found to cause transcription of DNA in plant cells can be used in the present invention. Such promoters may be obtained from a variety of sources such as plants and plant viruses. It is preferred that the particular promoter selected should be capable of causing sufficient expression to result in the production of an effective amount of the tocopherol synthesis pathway enzyme to cause the desired phenotype. In addition to promoters that are known to cause transcription of DNA in plant cells, other promoters may be identified for use in the current invention by screening a plant cDNA library for genes which are selectively or preferably expressed in the target tissues or cells.

10 For the purpose of expression in source tissues of the plant, such as the leaf, seed, root or stem, it is preferred that the promoters utilized in the present invention have relatively high expression in these specific tissues. For this purpose, one may choose from a number of promoters for genes with tissue- or cell-specific or -enhanced expression. Examples of such promoters reported in the literature include the chloroplast glutamine synthetase GS2 promoter from pea (Edwards *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 87:3459-3463 (1990), herein incorporated by reference in its entirety), the chloroplast fructose-1,6-biphosphatase (FBPase) promoter from wheat (Lloyd *et al.*, *Mol. Gen. Genet.* 225:209-216 (1991), herein incorporated by reference in its entirety), the nuclear photosynthetic ST-LS1 promoter from potato (Stockhaus *et al.*, *EMBO J.* 8:2445-2451 (1989), herein incorporated by reference in its entirety), the serine/threonine kinase (PAL) promoter and the glucoamylase (CHS) promoter from *Arabidopsis*

thaliana. Also reported to be active in photosynthetically active tissues are the ribulose-1,5-bisphosphate carboxylase (RbcS) promoter from eastern larch (*Larix laricina*), the promoter for the *cab* gene, *cab6*, from pine (Yamamoto *et al.*, *Plant Cell Physiol.* 35:773-778 (1994), herein incorporated by reference in its entirety), the promoter for the Cab-1 gene from wheat (Fejes *et al.*, *Plant Mol. Biol.* 15:921-932 (1990), herein incorporated by reference in its entirety), the promoter for the CAB-1 gene from spinach (Lubberstedt *et al.*, *Plant Physiol.* 104:997-1006 (1994), herein incorporated by reference in its entirety), the promoter for the cab1R gene from rice (Luan *et al.*, *Plant Cell.* 4:971-981 (1992), the entirety of which is herein incorporated by reference), the pyruvate, orthophosphate dikinase (PPDK) promoter from maize (Matsuoka *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 90: 9586-9590 (1993), herein incorporated by reference in its entirety), the promoter for the tobacco Lhcb1*2 gene (Cerdan *et al.*, *Plant Mol. Biol.* 33:245-255 (1997), herein incorporated by reference in its entirety), the *Arabidopsis thaliana* SUC2 sucrose-H⁺ symporter promoter (Truernit *et al.*, *Planta.* 196:564-570 (1995), herein incorporated by reference in its entirety) and the promoter for the thylakoid membrane proteins from spinach (*psaD*, *psaF*, *psaE*, *PC*, *FNR*, *atpC*, *atpD*, *cab*, *rbcS*). Other promoters for the chlorophyll a/b binding proteins may also be utilized in the present invention, such as the promoters for LhcB gene and PsbP gene from white mustard (*Sinapis alba*; Kretsch *et al.*, *Plant Mol. Biol.* 28:219-229 (1995), the entirety of which is herein incorporated by reference).

For the purpose of expression in sink tissues of the plant, such as the tuber of the potato plant, the fruit of tomato, or the seed of maize, wheat, rice and barley, it is preferred that the promoters utilized in the present invention have relatively high expression in these specific tissues. A number of promoters for genes with tuber-specific or -enhanced expression are known, including the class I patatin promoter (Bevan *et al.*, *EMBO J.* 8:1899-1906 (1986);

Jefferson *et al.*, *Plant Mol. Biol.* 14:995-1006 (1990), both of which are herein incorporated by reference in its entirety), the promoter for the potato tuber ADPGPP genes, both the large and small subunits, the sucrose synthase promoter (Salanoubat and Belliard, *Gene*. 60:47-56 (1987), Salanoubat and Belliard, *Gene*. 84:181-185 (1989), both of which are incorporated by reference in their entirety), the promoter for the major tuber proteins including the 22 kd protein complexes and proteinase inhibitors (Hannapel, *Plant Physiol.* 101:703-704 (1993), herein incorporated by reference in its entirety), the promoter for the granule bound starch synthase gene (GBSS) (Visser *et al.*, *Plant Mol. Biol.* 17:691-699 (1991), herein incorporated by reference in its entirety) and other class I and II patatins promoters (Koster-Topfer *et al.*, *Mol Gen Genet.* 219:390-396 (1989); Mignery *et al.*, *Gene*. 62:27-44 (1988), both of which are herein incorporated by reference in their entirety).

Other promoters can also be used to express a tocopherol synthesis pathway enzyme or fragment thereof in specific tissues, such as seeds or fruits. The promoter for β -conglycinin (Chen *et al.*, *Dev. Genet.* 10: 112-122 (1989), herein incorporated by reference in its entirety) or other seed-specific promoters such as the napin and phaseolin promoters, can be used. The zeins are a group of storage proteins found in maize endosperm. Genomic clones for zein genes have been isolated (Pedersen *et al.*, *Cell* 29:1015-1026 (1982), herein incorporated by reference in its entirety) and the promoters from these clones, including the 15 kD, 16 kD, 19 kD, 22 kD, 27 kD and γ genes, could also be used. Other promoters known to function, for example, in maize include the promoters for the following genes: *waxy*, *Brittle*, *Shrunken 2*, Branching enzymes I and II, starch synthases, debranching enzymes, oleosins, glutelins and sucrose synthases. A particularly preferred promoter for maize endosperm expression is the promoter for the glutelin

gene from rice, more particularly the Osgt-1 promoter (Zheng *et al.*, *Mol. Cell Biol.* 13:5829-5842 (1993), herein incorporated by reference in its entirety). Examples of promoters suitable for expression in wheat include those promoters for the ADPglucose pyrosynthase (ADPGPP) subunits, the granule bound and other starch synthase, the branching and debranching enzymes, the embryogenesis-abundant proteins, the gliadins and the glutenins. Examples of such promoters in rice include those promoters for the ADPGPP subunits, the granule bound and other starch synthase, the branching enzymes, the debranching enzymes, sucrose synthases and the glutelins. A particularly preferred promoter is the promoter for rice glutelin, Osgt-1. Examples of such promoters for barley include those for the ADPGPP subunits, the granule bound and other starch synthase, the branching enzymes, the debranching enzymes, sucrose synthases, the hordeins, the embryo globulins and the aleurone specific proteins.

Root specific promoters may also be used. An example of such a promoter is the promoter for the acid chitinase gene (Samac *et al.*, *Plant Mol. Biol.* 25:587-596 (1994), the entirety of which is herein incorporated by reference). Expression in root tissue could also be accomplished by utilizing the root specific subdomains of the CaMV35S promoter that have been identified (Lam *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 86:7890-7894 (1989), herein incorporated by reference in its entirety). Other root cell specific promoters include those reported by Conkling *et al.* (Conkling *et al.*, *Plant Physiol.* 93:1203-1211 (1990), the entirety of which is herein incorporated by reference).

Additional promoters that may be utilized are described, for example, in U.S. Patent Nos. 5,378,619; 5,391,725; 5,428,147; 5,447,858; 5,608,144; 5,608,144; 5,614,399; 5,633,441; 5,633,435; and 4,633,436, all of which are herein incorporated in their entirety. In addition, a

tissue specific enhancer may be used (Fromm *et al.*, *The Plant Cell* 1:977-984 (1989), the entirety of which is herein incorporated by reference).

Constructs or vectors may also include with the coding region of interest a nucleic acid sequence that acts, in whole or in part, to terminate transcription of that region. For example, such sequences have been isolated including the Tr7 3' sequence and the NOS 3' sequence (Ingelbrecht *et al.*, *The Plant Cell* 1:671-680 (1989), the entirety of which is herein incorporated by reference; Bevan *et al.*, *Nucleic Acids Res.* 11:369-385 (1983), the entirety of which is herein incorporated by reference), or the like.

A vector or construct may also include regulatory elements. Examples of such include the Adh intron 1 (Callis *et al.*, *Genes and Develop.* 1:1183-1200 (1987), the entirety of which is herein incorporated by reference), the sucrose synthase intron (Vasil *et al.*, *Plant Physiol.* 91:1575-1579 (1989), the entirety of which is herein incorporated by reference) and the TMV omega element (Gallie *et al.*, *The Plant Cell* 1:301-311 (1989), the entirety of which is herein incorporated by reference). These and other regulatory elements may be included when appropriate.

A vector or construct may also include a selectable marker. Selectable markers may also be used to select for plants or plant cells that contain the exogenous genetic material. Examples of such include, but are not limited to, a neo gene (Potrykus *et al.*, *Mol. Gen. Genet.* 199:183-188 (1985), the entirety of which is herein incorporated by reference) which codes for kanamycin resistance and can be selected for using kanamycin, G418, etc.; a bar gene which codes for bialaphos resistance; a mutant EPSP synthase gene (Hinchey *et al.*, *Bio/Technology* 6:915-922 (1988), the entirety of which is herein incorporated by reference) which encodes glyphosate resistance; a nitrilase gene which confers resistance to bromoxynil (Stalker *et al.*, *J. Biol. Chem.*

263:6310-6314 (1988), the entirety of which is herein incorporated by reference); a mutant acetolactate synthase gene (ALS) which confers imidazolinone or sulphonylurea resistance (European Patent Application 154,204 (Sept. 11, 1985), the entirety of which is herein incorporated by reference); and a methotrexate resistant DHFR gene (Thillet *et al.*, *J. Biol. Chem.* 5 263:12500-12508 (1988), the entirety of which is herein incorporated by reference).

A vector or construct may also include a transit peptide. Incorporation of a suitable chloroplast transit peptide may also be employed (European Patent Application Publication Number 0218571, the entirety of which is herein incorporated by reference). Translational enhancers may also be incorporated as part of the vector DNA. DNA constructs could contain one or more 5' non-translated leader sequences which may serve to enhance expression of the gene products from the resulting mRNA transcripts. Such sequences may be derived from the promoter selected to express the gene or can be specifically modified to increase translation of the mRNA. Such regions may also be obtained from viral RNAs, from suitable eukaryotic genes, or from a synthetic gene sequence. For a review of optimizing expression of transgenes, see Koziel *et al.*, *Plant Mol. Biol.* 32:393-405 (1996), the entirety of which is herein incorporated by reference.

A vector or construct may also include a screenable marker. Screenable markers may be used to monitor expression. Exemplary screenable markers include a β -glucuronidase or uidA gene (GUS) which encodes an enzyme for which various chromogenic substrates are known (Jefferson, *Plant Mol. Biol. Rep.* 5:387-405 (1987), the entirety of which is herein incorporated by reference; Jefferson *et al.*, *EMBO J.* 6:3901-3907 (1987), the entirety of which is herein incorporated by reference); an R-locus gene, which encodes a product that regulates the

production of anthocyanin pigments (red color) in plant tissues (Dellaporta *et al.*, Stadler Symposium 11:263-282 (1988), the entirety of which is herein incorporated by reference); a β -lactamase gene (Sutcliffe *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 75:3737-3741 (1978), the entirety of which is herein incorporated by reference), a gene which encodes an enzyme for which various chromogenic substrates are known (e.g., PADAC, a chromogenic cephalosporin); a luciferase gene (Ow *et al.*, *Science* 234:856-859 (1986), the entirety of which is herein incorporated by reference); a xyle gene (Zukowsky *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 80:1101-1105 (1983), the entirety of which is herein incorporated by reference) which encodes a catechol dioxygenase that can convert chromogenic catechols; an α -amylase gene (Ikata *et al.*, *Bio/Technol.* 8:241-242 (1990), the entirety of which is herein incorporated by reference); a tyrosinase gene (Katz *et al.*, *J. Gen. Microbiol.* 129:2703-2714 (1983), the entirety of which is herein incorporated by reference) which encodes an enzyme capable of oxidizing tyrosine to DOPA and dopaquinone which in turn condenses to melanin; an α -galactosidase, which will turn a chromogenic α -galactose substrate.

Included within the terms "selectable or screenable marker genes" are also genes which encode a secretable marker whose secretion can be detected as a means of identifying or selecting for transformed cells. Examples include markers which encode a secretable antigen that can be identified by antibody interaction, or even secretable enzymes which can be detected catalytically. Secretable proteins fall into a number of classes, including small, diffusible proteins which are detectable, (e.g., by ELISA), small active enzymes which are detectable in extracellular solution (e.g., α -amylase, β -lactamase, phosphinothricin transferase), or proteins which are inserted or trapped in the cell wall (such as proteins which include a leader sequence

such as that found in the expression unit of extension or tobacco PR-S). Other possible selectable and/or screenable marker genes will be apparent to those of skill in the art.

There are many methods for introducing transforming nucleic acid molecules into plant cells. Suitable methods are believed to include virtually any method by which nucleic acid molecules may be introduced into a cell, such as by *Agrobacterium* infection or direct delivery of nucleic acid molecules such as, for example, by PEG-mediated transformation, by electroporation or by acceleration of DNA coated particles, etc (Potrykus, *Ann. Rev. Plant Physiol. Plant Mol. Biol.* 42:205-225 (1991), the entirety of which is herein incorporated by reference; Vasil, *Plant Mol. Biol.* 25:925-937 (1994), the entirety of which is herein incorporated by reference). For example, electroporation has been used to transform maize protoplasts (Fromm *et al.*, *Nature* 312:791-793 (1986), the entirety of which is herein incorporated by reference).

Other vector systems suitable for introducing transforming DNA into a host plant cell include but are not limited to binary artificial chromosome (BIBAC) vectors (Hamilton *et al.*, *Gene* 200:107-116 (1997), the entirety of which is herein incorporated by reference); and transfection with RNA viral vectors (Della-Cioppa *et al.*, *Ann. N.Y. Acad. Sci.* (1996), 792 (Engineering Plants for Commercial Products and Applications), 57-61, the entirety of which is herein incorporated by reference). Additional vector systems also include plant selectable YAC vectors such as those described in Mullen *et al.*, *Molecular Breeding* 4:449-457 (1988), the entirety of which is herein incorporated by reference).

Technology for introduction of DNA into cells is well known to those of skill in the art. Four general methods for delivering a gene into cells have been described: (1) chemical methods (Graham and van der Eb, *Virology* 54:536-539 (1973), the entirety of which is herein

incorporated by reference); (2) physical methods such as microinjection (Capecchi, *Cell* 22:479-488 (1980), the entirety of which is herein incorporated by reference), electroporation (Wong and Neumann, *Biochem. Biophys. Res. Commun.* 107:584-587 (1982); Fromm *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 82:5824-5828 (1985); U.S. Patent No. 5,384,253, all of which are herein
5 incorporated in their entirety); and the gene gun (Johnston and Tang, *Methods Cell Biol.* 43:353-365 (1994), the entirety of which is herein incorporated by reference); (3) viral vectors (Clapp, *Clin. Perinatol.* 20:155-168 (1993); Lu *et al.*, *J. Exp. Med.* 178:2089-2096 (1993); Eglitis and Anderson, *Biotechniques* 6:608-614 (1988), all of which are herein incorporated in their entirety); and (4) receptor-mediated mechanisms (Curiel *et al.*, *Hum. Gen. Ther.* 3:147-154 (1992), Wagner *et al.*, *Proc. Natl. Acad. Sci. (USA)* 89:6099-6103 (1992), both of which are incorporated by reference in their entirety).

Acceleration methods that may be used include, for example, microprojectile bombardment and the like. One example of a method for delivering transforming nucleic acid molecules to plant cells is microprojectile bombardment. This method has been reviewed by Yang and Christou (eds.), *Particle Bombardment Technology for Gene Transfer*, Oxford Press, Oxford, England (1994), the entirety of which is herein incorporated by reference). Non-biological particles (microprojectiles) that may be coated with nucleic acids and delivered into cells by a propelling force. Exemplary particles include those comprised of tungsten, gold, platinum and the like.

20 A particular advantage of microprojectile bombardment, in addition to it being an effective means of reproducibly transforming monocots, is that neither the isolation of protoplasts (Cristou *et al.*, *Plant Physiol.* 87:671-674 (1988), the entirety of which is herein incorporated by reference) nor the susceptibility of *Agrobacterium* infection are required. An

illustrative embodiment of a method for delivering DNA into maize cells by acceleration is a biolistics α -particle delivery system, which can be used to propel particles coated with DNA through a screen, such as a stainless steel or Nytex screen, onto a filter surface covered with corn cells cultured in suspension. Gordon-Kamm *et al.*, describes the basic procedure for coating tungsten particles with DNA (Gordon-Kamm *et al.*, *Plant Cell* 2:603-618 (1990), the entirety of which is herein incorporated by reference). The screen disperses the tungsten nucleic acid particles so that they are not delivered to the recipient cells in large aggregates. A particle delivery system suitable for use with the present invention is the helium acceleration PDS-1000/He gun is available from Bio-Rad Laboratories (Bio-Rad, Hercules, California)(Sanford *et al.*, *Technique* 3:3-16 (1991), the entirety of which is herein incorporated by reference).

For the bombardment, cells in suspension may be concentrated on filters. Filters containing the cells to be bombarded are positioned at an appropriate distance below the microprojectile stopping plate. If desired, one or more screens are also positioned between the gun and the cells to be bombarded.

Alternatively, immature embryos or other target cells may be arranged on solid culture medium. The cells to be bombarded are positioned at an appropriate distance below the microprojectile stopping plate. If desired, one or more screens are also positioned between the acceleration device and the cells to be bombarded. Through the use of techniques set forth herein one may obtain up to 1000 or more foci of cells transiently expressing a marker gene. The number of cells in a focus which express the exogenous gene product 48 hours post-bombardment often range from one to ten and average one to three.

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In bombardment transformation, one may optimize the pre-bombardment culturing conditions and the bombardment parameters to yield the maximum numbers of stable transformants. Both the physical and biological parameters for bombardment are important in this technology. Physical factors are those that involve manipulating the DNA/microprojectile precipitate or those that affect the flight and velocity of either the macro- or microprojectiles. Biological factors include all steps involved in manipulation of cells before and immediately after bombardment, the osmotic adjustment of target cells to help alleviate the trauma associated with bombardment and also the nature of the transforming DNA, such as linearized DNA or intact supercoiled plasmids. It is believed that pre-bombardment manipulations are especially important for successful transformation of immature embryos.

In another alternative embodiment, plastids can be stably transformed. Methods disclosed for plastid transformation in higher plants include the particle gun delivery of DNA containing a selectable marker and targeting of the DNA to the plastid genome through homologous recombination (Svab *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 87:8526-8530 (1990); Svab and Maliga, *Proc. Natl. Acad. Sci. (U.S.A.)* 90:913-917 (1993); Staub and Maliga, *EMBO J.* 12:601-606 (1993); U.S. Patent Nos. 5, 451,513 and 5,545,818, all of which are herein incorporated by reference in their entirety).

Accordingly, it is contemplated that one may wish to adjust various aspects of the bombardment parameters in small scale studies to fully optimize the conditions. One may particularly wish to adjust physical parameters such as gap distance, flight distance, tissue distance and helium pressure. One may also minimize the trauma reduction factors by modifying conditions which influence the physiological state of the recipient cells and which may therefore influence transformation and integration efficiencies. For example, the osmotic state, tissue

hydration and the subculture stage or cell cycle of the recipient cells may be adjusted for optimum transformation. The execution of other routine adjustments will be known to those of skill in the art in light of the present disclosure.

Agrobacterium-mediated transfer is a widely applicable system for introducing genes into plant cells because the DNA can be introduced into whole plant tissues, thereby bypassing the need for regeneration of an intact plant from a protoplast. The use of *Agrobacterium*-mediated plant integrating vectors to introduce DNA into plant cells is well known in the art. See, for example the methods described by Fraley *et al.*, *Bio/Technology* 3:629-635 (1985) and Rogers *et al.*, *Methods Enzymol.* 153:253-277 (1987), both of which are herein incorporated by reference in their entirety. Further, the integration of the Ti-DNA is a relatively precise process resulting in few rearrangements. The region of DNA to be transferred is defined by the border sequences and intervening DNA is usually inserted into the plant genome as described (Spielmann *et al.*, *Mol. Gen. Genet.* 205:34 (1986), the entirety of which is herein incorporated by reference).

Modern *Agrobacterium* transformation vectors are capable of replication in *E. coli* as well as *Agrobacterium*, allowing for convenient manipulations as described (Klee *et al.*, In: *Plant DNA Infectious Agents*, Hohn and Schell (eds.), Springer-Verlag, New York, pp. 179-203 (1985), the entirety of which is herein incorporated by reference. Moreover, technological advances in vectors for *Agrobacterium*-mediated gene transfer have improved the arrangement of genes and restriction sites in the vectors to facilitate construction of vectors capable of expressing various polypeptide coding genes. The vectors described have convenient multi-linker regions flanked by a promoter and a polyadenylation site for direct expression of inserted polypeptide coding genes and are suitable for present purposes (Rogers *et al.*, *Methods Enzymol.* 153:253-277 (1987)). In addition, *Agrobacterium* containing both armed and disarmed Ti genes can be used

for the transformations. In those plant strains where *Agrobacterium*-mediated transformation is efficient, it is the method of choice because of the facile and defined nature of the gene transfer.

A transgenic plant formed using *Agrobacterium* transformation methods typically contains a single gene on one chromosome. Such transgenic plants can be referred to as being heterozygous for the added gene. More preferred is a transgenic plant that is homozygous for the added structural gene; *i.e.*, a transgenic plant that contains two added genes, one gene at the same locus on each chromosome of a chromosome pair. A homozygous transgenic plant can be obtained by sexually mating (selfing) an independent segregant transgenic plant that contains a single added gene, germinating some of the seed produced and analyzing the resulting plants produced for the gene of interest.

It is also to be understood that two different transgenic plants can also be mated to produce offspring that contain two independently segregating added, exogenous genes. Selfing of appropriate progeny can produce plants that are homozygous for both added, exogenous genes that encode a polypeptide of interest. Back-crossing to a parental plant and out-crossing with a non-transgenic plant are also contemplated, as is vegetative propagation.

Transformation of plant protoplasts can be achieved using methods based on calcium phosphate precipitation, polyethylene glycol treatment, electroporation and combinations of these treatments (*See, for example*, Potrykus *et al.*, *Mol. Gen. Genet.* 205:193-200 (1986); Lorz *et al.*, *Mol. Gen. Genet.* 199:178 (1985); Fromm *et al.*, *Nature* 319:791 (1986); Uchimiya *et al.*, *Mol. Gen. Genet.* 204:204 (1986); Marcotte *et al.*, *Nature* 335:454-457 (1988), all of which are herein incorporated by reference in their entirety).

Application of these systems to different plant strains depends upon the ability to regenerate that particular plant strain from protoplasts. Illustrative methods for the regeneration

of cereals from protoplasts are described (Fujimura *et al.*, *Plant Tissue Culture Letters* 2:74 (1985); Toriyama *et al.*, *Theor Appl. Genet.* 205:34 (1986); Yamada *et al.*, *Plant Cell Rep.* 4:85 (1986); Abdullah *et al.*, *Biotechnolog* 4:1087 (1986), all of which are herein incorporated by reference in their entirety).

5 To transform plant strains that cannot be successfully regenerated from protoplasts, other ways to introduce DNA into intact cells or tissues can be utilized. For example, regeneration of cereals from immature embryos or explants can be effected as described (Vasil, *Biotechnology* 6:397 (1988), the entirety of which is herein incorporated by reference). In addition, "particle gun" or high-velocity microprojectile technology can be utilized (Vasil *et al.*, *Bio/Technology* 10:667 (1992), the entirety of which is herein incorporated by reference).

Using the latter technology, DNA is carried through the cell wall and into the cytoplasm on the surface of small metal particles as described (Klein *et al.*, *Nature* 328:70 (1987); Klein *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 85:8502-8505 (1988); McCabe *et al.*, *Bio/Technology* 6:923 (1988), all of which are herein incorporated by reference in their entirety). The metal particles penetrate through several layers of cells and thus allow the transformation of cells within tissue explants.

Other methods of cell transformation can also be used and include but are not limited to introduction of DNA into plants by direct DNA transfer into pollen (Zhou *et al.*, *Methods Enzymol.* 101:433 (1983); Hess *et al.*, *Intern Rev. Cytol.* 107:367 (1987); Luo *et al.*, *Plant Mol Biol. Reporter* 6:165 (1988), all of which are herein incorporated by reference in their entirety),
20 by direct injection of DNA into reproductive organs of a plant (Pena *et al.*, *Nature* 325:274 (1987), the entirety of which is herein incorporated by reference), or by direct injection of DNA into the cells of immature embryos followed by the rehydration of desiccated embryos (Neuhaus

et al., *Theor. Appl. Genet.* 75:30 (1987), the entirety of which is herein incorporated by reference).

The regeneration, development and cultivation of plants from single plant protoplast transformants or from various transformed explants is well known in the art (Weissbach and Weissbach, In: *Methods for Plant Molecular Biology*, Academic Press, San Diego, CA, (1988), the entirety of which is herein incorporated by reference). This regeneration and growth process typically includes the steps of selection of transformed cells, culturing those individualized cells through the usual stages of embryonic development through the rooted plantlet stage. Transgenic embryos and seeds are similarly regenerated. The resulting transgenic rooted shoots are thereafter planted in an appropriate plant growth medium such as soil.

The development or regeneration of plants containing the foreign, exogenous gene that encodes a protein of interest is well known in the art. Preferably, the regenerated plants are self-pollinated to provide homozygous transgenic plants. Otherwise, pollen obtained from the regenerated plants is crossed to seed-grown plants of agronomically important lines. Conversely, pollen from plants of these important lines is used to pollinate regenerated plants. A transgenic plant of the present invention containing a desired polypeptide is cultivated using methods well known to one skilled in the art.

There are a variety of methods for the regeneration of plants from plant tissue. The particular method of regeneration will depend on the starting plant tissue and the particular plant species to be regenerated.

Methods for transforming dicots, primarily by use of *Agrobacterium tumefaciens* and obtaining transgenic plants have been published for cotton (U.S. Patent No. 5,004,863; U.S. Patent No. 5,159,135; U.S. Patent No. 5,518,908, all of which are herein incorporated by

reference in their entirety); soybean (U.S. Patent No. 5,569,834; U.S. Patent No. 5,416,011; McCabe *et al.*, *Biotechnology* 6:923 (1988); Christou *et al.*, *Plant Physiol.* 87:671-674 (1988); all of which are herein incorporated by reference in their entirety); *Brassica* (U.S. Patent No. 5,463,174, the entirety of which is herein incorporated by reference); peanut (Cheng *et al.*, *Plant Cell Rep.* 15:653-657 (1996), McKently *et al.*, *Plant Cell Rep.* 14:699-703 (1995), all of which are herein incorporated by reference in their entirety); papaya; and pea (Grant *et al.*, *Plant Cell Rep.* 15:254-258 (1995), the entirety of which is herein incorporated by reference).

Transformation of monocotyledons using electroporation, particle bombardment and *Agrobacterium* have also been reported. Transformation and plant regeneration have been achieved in asparagus (Bytebier *et al.*, *Proc. Natl. Acad. Sci. (USA)* 84:5354 (1987), the entirety of which is herein incorporated by reference); barley (Wan and Lemaux, *Plant Physiol* 104:37 (1994), the entirety of which is herein incorporated by reference); maize (Rhodes *et al.*, *Science* 240:204 (1988); Gordon-Kamm *et al.*, *Plant Cell* 2:603-618 (1990); Fromm *et al.*, *Bio/Technology* 8:833 (1990); Koziel *et al.*, *Bio/Technology* 11:194 (1993); Armstrong *et al.*, *Crop Science* 35:550-557 (1995); all of which are herein incorporated by reference in their entirety); oat (Somers *et al.*, *Bio/Technology* 10:1589 (1992), the entirety of which is herein incorporated by reference); orchard grass (Horn *et al.*, *Plant Cell Rep.* 7:469 (1988), the entirety of which is herein incorporated by reference); rice (Toriyama *et al.*, *Theor Appl. Genet.* 205:34 (1986); Part *et al.*, *Plant Mol. Biol.* 32:1135-1148 (1996); Abedinia *et al.*, *Aust. J. Plant Physiol.* 24:133-141 (1997); Zhang and Wu, *Theor. Appl. Genet.* 76:835 (1988); Zhang *et al.*, *Plant Cell Rep.* 7:379 (1988); Battraw and Hall, *Plant Sci.* 86:191-202 (1992); Christou *et al.*, *Bio/Technology* 9:957 (1991), all of which are herein incorporated by reference in their entirety); rye (De la Pena *et al.*, *Nature* 325:274 (1987), the entirety of which is herein incorporated by

reference); sugarcane (Bower and Birch, *Plant J.* 2:409 (1992), the entirety of which is herein incorporated by reference); tall fescue (Wang *et al.*, *Bio/Technology* 10:691 (1992), the entirety of which is herein incorporated by reference) and wheat (Vasil *et al.*, *Bio/Technology* 10:667 (1992), the entirety of which is herein incorporated by reference; U.S. Patent No. 5,631,152, the entirety of which is herein incorporated by reference.)

Assays for gene expression based on the transient expression of cloned nucleic acid constructs have been developed by introducing the nucleic acid molecules into plant cells by polyethylene glycol treatment, electroporation, or particle bombardment (Marcotte *et al.*, *Nature* 335:454-457 (1988), the entirety of which is herein incorporated by reference; Marcotte *et al.*, *Plant Cell* 1:523-532 (1989), the entirety of which is herein incorporated by reference; McCarty *et al.*, *Cell* 66:895-905 (1991), the entirety of which is herein incorporated by reference; Hattori *et al.*, *Genes Dev.* 6:609-618 (1992), the entirety of which is herein incorporated by reference; Goff *et al.*, *EMBO J.* 9:2517-2522 (1990), the entirety of which is herein incorporated by reference). Transient expression systems may be used to functionally dissect gene constructs (see generally, Mailga *et al.*, *Methods in Plant Molecular Biology*, Cold Spring Harbor Press (1995)).

Any of the nucleic acid molecules of the present invention may be introduced into a plant cell in a permanent or transient manner in combination with other genetic elements such as vectors, promoters, enhancers etc. Further, any of the nucleic acid molecules of the present invention may be introduced into a plant cell in a manner that allows for overexpression of the protein or fragment thereof encoded by the nucleic acid molecule.

Cosuppression is the reduction in expression levels, usually at the level of RNA, of a particular endogenous gene or gene family by the expression of a homologous sense construct

that is capable of transcribing mRNA of the same strandedness as the transcript of the endogenous gene (Napoli *et al.*, *Plant Cell* 2:279-289 (1990), the entirety of which is herein incorporated by reference; van der Krol *et al.*, *Plant Cell* 2:291-299 (1990), the entirety of which is herein incorporated by reference). Cosuppression may result from stable transformation with a single copy nucleic acid molecule that is homologous to a nucleic acid sequence found with the cell (Prolls and Meyer, *Plant J.* 2:465-475 (1992), the entirety of which is herein incorporated by reference) or with multiple copies of a nucleic acid molecule that is homologous to a nucleic acid sequence found with the cell (Mittlesten *et al.*, *Mol. Gen. Genet.* 244:325-330 (1994), the entirety of which is herein incorporated by reference). Genes, even though different, linked to homologous promoters may result in the cosuppression of the linked genes (Vaucheret, *C.R. Acad. Sci. III* 316:1471-1483 (1993), the entirety of which is herein incorporated by reference).

This technique has, for example, been applied to generate white flowers from red petunia and tomatoes that do not ripen on the vine. Up to 50% of petunia transformants that contained a sense copy of the glucoamylase (CHS) gene produced white flowers or floral sectors; this was as a result of the post-transcriptional loss of mRNA encoding CHS (Flavell, *Proc. Natl. Acad. Sci. (U.S.A.)* 91:3490-3496 (1994), the entirety of which is herein incorporated by reference); van Blokland *et al.*, *Plant J.* 6:861-877 (1994), the entirety of which is herein incorporated by reference). Cosuppression may require the coordinate transcription of the transgene and the endogenous gene and can be reset by a developmental control mechanism (Jorgensen, *Trends Biotechnol.* 8:340-344 (1990), the entirety of which is herein incorporated by reference; Meins and Kunz, In: *Gene Inactivation and Homologous Recombination in Plants*, Paszkowski (ed.), pp. 335-348, Kluwer Academic, Netherlands (1994), the entirety of which is herein incorporated by reference).

It is understood that one or more of the nucleic acids of the present invention may be introduced into a plant cell and transcribed using an appropriate promoter with such transcription resulting in the cosuppression of an endogenous tocopherol synthesis pathway enzyme.

Antisense approaches are a way of preventing or reducing gene function by targeting the genetic material (Mol *et al.*, *FEBS Lett.* 268:427-430 (1990), the entirety of which is herein incorporated by reference). The objective of the antisense approach is to use a sequence complementary to the target gene to block its expression and create a mutant cell line or organism in which the level of a single chosen protein is selectively reduced or abolished.

Antisense techniques have several advantages over other 'reverse genetic' approaches. The site of inactivation and its developmental effect can be manipulated by the choice of promoter for antisense genes or by the timing of external application or microinjection. Antisense can manipulate its specificity by selecting either unique regions of the target gene or regions where it shares homology to other related genes (Hiatt *et al.*, In: *Genetic Engineering*, Setlow (ed.), Vol. 11, New York: Plenum 49-63 (1989), the entirety of which is herein incorporated by reference).

The principle of regulation by antisense RNA is that RNA that is complementary to the target mRNA is introduced into cells, resulting in specific RNA:RNA duplexes being formed by base pairing between the antisense substrate and the target mRNA (Green *et al.*, *Annu. Rev. Biochem.* 55:569-597 (1986), the entirety of which is herein incorporated by reference). Under one embodiment, the process involves the introduction and expression of an antisense gene sequence. Such a sequence is one in which part or all of the normal gene sequences are placed under a promoter in inverted orientation so that the 'wrong' or complementary strand is transcribed into a noncoding antisense RNA that hybridizes with the target mRNA and interferes with its expression (Takayama and Inouye, *Crit. Rev. Biochem. Mol. Biol.* 25:155-184 (1990),

the entirety of which is herein incorporated by reference). An antisense vector is constructed by standard procedures and introduced into cells by transformation, transfection, electroporation, microinjection, infection, etc. The type of transformation and choice of vector will determine whether expression is transient or stable. The promoter used for the antisense gene may influence the level, timing, tissue, specificity, or inducibility of the antisense inhibition.

It is understood that the activity of a tocopherol synthesis pathway enzyme in a plant cell may be reduced or depressed by growing a transformed plant cell containing a nucleic acid molecule whose non-transcribed strand encodes a tocopherol synthesis pathway enzyme or fragment thereof.

Antibodies have been expressed in plants (Hiatt *et al.*, *Nature* 342:76-78 (1989), the entirety of which is herein incorporated by reference; Conrad and Fielder, *Plant Mol. Biol.* 26:1023-1030 (1994), the entirety of which is herein incorporated by reference). Cytoplasmic expression of a scFv (single-chain Fv antibodies) has been reported to delay infection by artichoke mottled crinkle virus. Transgenic plants that express antibodies directed against endogenous proteins may exhibit a physiological effect (Philips *et al.*, *EMBO J.* 16:4489-4496 (1997), the entirety of which is herein incorporated by reference; Marion-Poll, *Trends in Plant Science* 2:447-448 (1997), the entirety of which is herein incorporated by reference). For example, expressed anti-abscisic antibodies have been reported to result in a general perturbation of seed development (Philips *et al.*, *EMBO J.* 16: 4489-4496 (1997)).

Antibodies that are catalytic may also be expressed in plants (abzymes). The principle behind abzymes is that since antibodies may be raised against many molecules, this recognition ability can be directed toward generating antibodies that bind transition states to force a chemical reaction forward (Persidas, *Nature Biotechnology* 15:1313-1315 (1997), the entirety of which is

herein incorporated by reference; Baca *et al.*, *Ann. Rev. Biophys. Biomol. Struct.* 26:461-493 (1997), the entirety of which is herein incorporated by reference). The catalytic abilities of abzymes may be enhanced by site directed mutagenesis. Examples of abzymes are, for example, set forth in U.S. Patent No. 5,658,753; U.S. Patent No. 5,632,990; U.S. Patent No. 5,631,137; 5 U.S. Patent 5,602,015; U.S. Patent No. 5,559,538; U.S. Patent No. 5,576,174; U.S. Patent No. 5,500,358; U.S. Patent No. 5,318,897; U.S. Patent No. 5,298,409; U.S. Patent No. 5,258,289 and U.S. Patent No. 5,194,585, all of which are herein incorporated in their entirety.

It is understood that any of the antibodies of the present invention may be expressed in plants and that such expression can result in a physiological effect. It is also understood that any of the expressed antibodies may be catalytic.

(b) Fungal Constructs and Fungal Transformants

The present invention also relates to a fungal recombinant vector comprising exogenous genetic material. The present invention also relates to a fungal cell comprising a fungal recombinant vector. The present invention also relates to methods for obtaining a recombinant fungal host cell comprising introducing into a fungal host cell exogenous genetic material.

Exogenous genetic material may be transferred into a fungal cell. In a preferred embodiment the exogenous genetic material includes a nucleic acid molecule of the present invention having a sequence selected from the group consisting of SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof or fragments of either or other nucleic acid molecule of the present invention. The fungal recombinant vector may be any vector which can be conveniently subjected to recombinant DNA procedures. The choice of a vector will typically depend on the compatibility of the vector with the fungal host cell into which the vector is to be introduced. The vector may be a linear or a closed circular plasmid. The vector system may be a single

vector or plasmid or two or more vectors or plasmids which together contain the total DNA to be introduced into the genome of the fungal host.

The fungal vector may be an autonomously replicating vector, *i.e.*, a vector which exists as an extrachromosomal entity, the replication of which is independent of chromosomal replication, *e.g.*, a plasmid, an extrachromosomal element, a minichromosome, or an artificial chromosome. The vector may contain any means for assuring self-replication. Alternatively, the vector may be one which, when introduced into the fungal cell, is integrated into the genome and replicated together with the chromosome(s) into which it has been integrated. For integration, the vector may rely on the nucleic acid sequence of the vector for stable integration of the vector into the genome by homologous or nonhomologous recombination. Alternatively, the vector may contain additional nucleic acid sequences for directing integration by homologous recombination into the genome of the fungal host. The additional nucleic acid sequences enable the vector to be integrated into the host cell genome at a precise location(s) in the chromosome(s). To increase the likelihood of integration at a precise location, there should be preferably two nucleic acid sequences which individually contain a sufficient number of nucleic acids, preferably 400bp to 1500bp, more preferably 800bp to 1000bp, which are highly homologous with the corresponding target sequence to enhance the probability of homologous recombination. These nucleic acid sequences may be any sequence that is homologous with a target sequence in the genome of the fungal host cell and, furthermore, may be non-encoding or encoding sequences.

For autonomous replication, the vector may further comprise an origin of replication enabling the vector to replicate autonomously in the host cell in question. Examples of origin of replications for use in a yeast host cell are the 2 micron origin of replication and the combination

of CEN3 and ARS 1. Any origin of replication may be used which is compatible with the fungal host cell of choice.

The fungal vectors of the present invention preferably contain one or more selectable markers which permit easy selection of transformed cells. A selectable marker is a gene the product of which provides, for example biocide or viral resistance, resistance to heavy metals, prototrophy to auxotrophs and the like. The selectable marker may be selected from the group including, but not limited to, *amdS* (acetamidase), *argB* (ornithine carbamoyltransferase), *bar* (phosphinothricin acetyltransferase), *hygB* (hygromycin phosphotransferase), *niaD* (nitrate reductase), *pyrG* (orotidine-5'-phosphate decarboxylase) and *sC* (sulfate adenylyltransferase) and *trpC* (anthranilate synthase). Preferred for use in an *Aspergillus* cell are the *amdS* and *pyrG* markers of *Aspergillus nidulans* or *Aspergillus oryzae* and the *bar* marker of *Streptomyces hygroscopicus*. Furthermore, selection may be accomplished by co-transformation, *e.g.*, as described in WO 91/17243, the entirety of which is herein incorporated by reference. A nucleic acid sequence of the present invention may be operably linked to a suitable promoter sequence. The promoter sequence is a nucleic acid sequence which is recognized by the fungal host cell for expression of the nucleic acid sequence. The promoter sequence contains transcription and translation control sequences which mediate the expression of the protein or fragment thereof.

A promoter may be any nucleic acid sequence which shows transcriptional activity in the fungal host cell of choice and may be obtained from genes encoding polypeptides either homologous or heterologous to the host cell. Examples of suitable promoters for directing the transcription of a nucleic acid construct of the invention in a filamentous fungal host are promoters obtained from the genes encoding *Aspergillus oryzae* TAKA amylase, *Rhizomucor miehei* aspartic proteinase, *Aspergillus niger* neutral alpha-amylase, *Aspergillus niger* acid stable

alpha-amylase, *Aspergillus niger* or *Aspergillus awamori* glucoamylase (glaA), *Rhizomucor miehei* lipase, *Aspergillus oryzae* alkaline protease, *Aspergillus oryzae* triose phosphate isomerase, *Aspergillus nidulans* acetamidase and hybrids thereof. In a yeast host, a useful promoter is the *Saccharomyces cerevisiae* enolase (eno-1) promoter. Particularly preferred promoters are the TAKA amylase, NA2-tpi (a hybrid of the promoters from the genes encoding *Aspergillus niger* neutral alpha -amylase and *Aspergillus oryzae* triose phosphate isomerase) and glaA promoters.

A protein or fragment thereof encoding nucleic acid molecule of the present invention may also be operably linked to a terminator sequence at its 3' terminus. The terminator sequence may be native to the nucleic acid sequence encoding the protein or fragment thereof or may be obtained from foreign sources. Any terminator which is functional in the fungal host cell of choice may be used in the present invention, but particularly preferred terminators are obtained from the genes encoding *Aspergillus oryzae* TAKA amylase, *Aspergillus niger* glucoamylase, *Aspergillus nidulans* anthranilate synthase, *Aspergillus niger* alpha-glucosidase and *Saccharomyces cerevisiae* enolase.

A protein or fragment thereof encoding nucleic acid molecule of the present invention may also be operably linked to a suitable leader sequence. A leader sequence is a nontranslated region of a mRNA which is important for translation by the fungal host. The leader sequence is operably linked to the 5' terminus of the nucleic acid sequence encoding the protein or fragment thereof. The leader sequence may be native to the nucleic acid sequence encoding the protein or fragment thereof or may be obtained from foreign sources. Any leader sequence which is functional in the fungal host cell of choice may be used in the present invention, but particularly

preferred leaders are obtained from the genes encoding *Aspergillus oryzae* TAKA amylase and *Aspergillus oryzae* triose phosphate isomerase.

A polyadenylation sequence may also be operably linked to the 3' terminus of the nucleic acid sequence of the present invention. The polyadenylation sequence is a sequence which when transcribed is recognized by the fungal host to add polyadenosine residues to transcribed mRNA. The polyadenylation sequence may be native to the nucleic acid sequence encoding the protein or fragment thereof or may be obtained from foreign sources. Any polyadenylation sequence which is functional in the fungal host of choice may be used in the present invention, but particularly preferred polyadenylation sequences are obtained from the genes encoding *Aspergillus oryzae* TAKA amylase, *Aspergillus niger* glucoamylase, *Aspergillus nidulans* anthranilate synthase and *Aspergillus niger* alpha-glucosidase.

To avoid the necessity of disrupting the cell to obtain the protein or fragment thereof and to minimize the amount of possible degradation of the expressed protein or fragment thereof within the cell, it is preferred that expression of the protein or fragment thereof gives rise to a product secreted outside the cell. To this end, a protein or fragment thereof of the present invention may be linked to a signal peptide linked to the amino terminus of the protein or fragment thereof. A signal peptide is an amino acid sequence which permits the secretion of the protein or fragment thereof from the fungal host into the culture medium. The signal peptide may be native to the protein or fragment thereof of the invention or may be obtained from foreign sources. The 5' end of the coding sequence of the nucleic acid sequence of the present invention may inherently contain a signal peptide coding region naturally linked in translation reading frame with the segment of the coding region which encodes the secreted protein or fragment thereof. Alternatively, the 5' end of the coding sequence may contain a signal peptide

coding region which is foreign to that portion of the coding sequence which encodes the secreted protein or fragment thereof. The foreign signal peptide may be required where the coding sequence does not normally contain a signal peptide coding region. Alternatively, the foreign signal peptide may simply replace the natural signal peptide to obtain enhanced secretion of the desired protein or fragment thereof. The foreign signal peptide coding region may be obtained from a glucoamylase or an amylase gene from an *Aspergillus* species, a lipase or proteinase gene from *Rhizomucor miehei*, the gene for the alpha-factor from *Saccharomyces cerevisiae*, or the calf preprochymosin gene. An effective signal peptide for fungal host cells is the *Aspergillus oryzae* TAKA amylase signal, *Aspergillus niger* neutral amylase signal, the *Rhizomucor miehei* aspartic proteinase signal, the *Humicola lanuginosus* cellulase signal, or the *Rhizomucor miehei* lipase signal. However, any signal peptide capable of permitting secretion of the protein or fragment thereof in a fungal host of choice may be used in the present invention.

A protein or fragment thereof encoding nucleic acid molecule of the present invention may also be linked to a propeptide coding region. A propeptide is an amino acid sequence found at the amino terminus of a proprotein or proenzyme. Cleavage of the propeptide from the proprotein yields a mature biochemically active protein. The resulting polypeptide is known as a propolypeptide or proenzyme (or a zymogen in some cases). Propolypeptides are generally inactive and can be converted to mature active polypeptides by catalytic or autocatalytic cleavage of the propeptide from the propolypeptide or proenzyme. The propeptide coding region may be native to the protein or fragment thereof or may be obtained from foreign sources. The foreign propeptide coding region may be obtained from the *Saccharomyces cerevisiae* alpha-factor gene or *Myceliophthora thermophila* laccase gene (WO 95/33836, the entirety of which is herein incorporated by reference).

The procedures used to ligate the elements described above to construct the recombinant expression vector of the present invention are well known to one skilled in the art (see, for example, Sambrook *et al.*, *Molecular Cloning, A Laboratory Manual*, 2nd ed., Cold Spring Harbor, N.Y., (1989)).

5 The present invention also relates to recombinant fungal host cells produced by the methods of the present invention which are advantageously used with the recombinant vector of the present invention. The cell is preferably transformed with a vector comprising a nucleic acid sequence of the invention followed by integration of the vector into the host chromosome. The choice of fungal host cells will to a large extent depend upon the gene encoding the protein or fragment thereof and its source. The fungal host cell may, for example, be a yeast cell or a filamentous fungal cell.

10 "Yeast" as used herein includes *Ascosporogenous* yeast (*Endomycetales*), *Basidiosporogenous* yeast and yeast belonging to the *Fungi Imperfecti* (*Blastomycetes*). The *Ascosporogenous* yeasts are divided into the families *Spermophthoraceae* and *Saccharomycetaceae*. The latter is comprised of four subfamilies, *Schizosaccharomycoideae* (for example, genus *Schizosaccharomyces*), *Nadsonioideae*, *Lipomycoideae* and *Saccharomycoideae* (for example, genera *Pichia*, *Kluyveromyces* and *Saccharomyces*). The *Basidiosporogenous* yeasts include the genera *Leucosporidim*, *Rhodosporidium*, *Sporidiobolus*, *Filobasidium* and *Filobasidiella*. Yeast belonging to the *Fungi Imperfecti* are divided into two families,

15 20 *Sporobolomycetaceae* (for example, genera *Sorobolomyces* and *Bullera*) and *Cryptococcaceae* (for example, genus *Candida*). Since the classification of yeast may change in the future, for the purposes of this invention, yeast shall be defined as described in *Biology and Activities of Yeast* (Skinner *et al.*, *Soc. App. Bacteriol. Symposium Series* No. 9, (1980), the entirety of which is

herein incorporated by reference). The biology of yeast and manipulation of yeast genetics are well known in the art (see, for example, *Biochemistry and Genetics of Yeast*, Bacil *et al.* (ed.), 2nd edition, 1987; *The Yeasts*, Rose and Harrison (eds.), 2nd ed., (1987); and *The Molecular Biology of the Yeast Saccharomyces*, Strathern *et al.* (eds.), (1981), all of which are herein
5 incorporated by reference in their entirety).

"Fungi" as used herein includes the phyla *Ascomycota*, *Basidiomycota*, *Chytridiomycota* and *Zygomycota* (as defined by Hawksworth *et al.*, In: Ainsworth and Bisby's *Dictionary of The Fungi*, 8th edition, 1995, CAB International, University Press, Cambridge, UK; the entirety of which is herein incorporated by reference) as well as the *Oomycota* (as cited in Hawksworth *et al.*, In: Ainsworth and Bisby's *Dictionary of The Fungi*, 8th edition, 1995, CAB International, University Press, Cambridge, UK) and all mitosporic fungi (Hawksworth *et al.*, In: Ainsworth and Bisby's *Dictionary of The Fungi*, 8th edition, 1995, CAB International, University Press, Cambridge, UK). Representative groups of *Ascomycota* include, for example, *Neurospora*, *Eupenicillium* (= *Penicillium*), *Emericella* (= *Aspergillus*), *Eurotium* (= *Aspergillus*) and the true yeasts listed above. Examples of *Basidiomycota* include mushrooms, rusts and smuts. Representative groups of *Chytridiomycota* include, for example, *Allomyces*, *Blastocladiella*, *Coelomomyces* and aquatic fungi. Representative groups of *Oomycota* include, for example, *Saprolegniomycetous* aquatic fungi (water molds) such as *Achlya*. Examples of mitosporic fungi include *Aspergillus*, *Penicillium*, *Candida* and *Alternaria*. Representative groups of *Zygomycota*
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20 include, for example, *Rhizopus* and *Mucor*.

"Filamentous fungi" include all filamentous forms of the subdivision *Eumycota* and *Oomycota* (as defined by Hawksworth *et al.*, In: Ainsworth and Bisby's *Dictionary of The Fungi*, 8th edition, 1995, CAB International, University Press, Cambridge, UK). The filamentous fungi

are characterized by a vegetative mycelium composed of chitin, cellulose, glucan, chitosan, mannan and other complex polysaccharides. Vegetative growth is by hyphal elongation and carbon catabolism is obligately aerobic. In contrast, vegetative growth by yeasts such as *Saccharomyces cerevisiae* is by budding of a unicellular thallus and carbon catabolism may be fermentative.

In one embodiment, the fungal host cell is a yeast cell. In a preferred embodiment, the yeast host cell is a cell of the species of *Candida*, *Kluyveromyces*, *Saccharomyces*, *Schizosaccharomyces*, *Pichia* and *Yarrowia*. In a preferred embodiment, the yeast host cell is a *Saccharomyces cerevisiae* cell, a *Saccharomyces carlsbergensis*, *Saccharomyces diastaticus* cell, a *Saccharomyces douglasii* cell, a *Saccharomyces kluyveri* cell, a *Saccharomyces norbensis* cell, or a *Saccharomyces oviformis* cell. In another preferred embodiment, the yeast host cell is a *Kluyveromyces lactis* cell. In another preferred embodiment, the yeast host cell is a *Yarrowia lipolytica* cell.

In another embodiment, the fungal host cell is a filamentous fungal cell. In a preferred embodiment, the filamentous fungal host cell is a cell of the species of, but not limited to, *Acremonium*, *Aspergillus*, *Fusarium*, *Humicola*, *Myceliophthora*, *Mucor*, *Neurospora*, *Penicillium*, *Thielavia*, *Tolypocladium* and *Trichoderma*. In a preferred embodiment, the filamentous fungal host cell is an *Aspergillus* cell. In another preferred embodiment, the filamentous fungal host cell is an *Acremonium* cell. In another preferred embodiment, the filamentous fungal host cell is a *Fusarium* cell. In another preferred embodiment, the filamentous fungal host cell is a *Humicola* cell. In another preferred embodiment, the filamentous fungal host cell is a *Myceliophthora* cell. In another even preferred embodiment, the filamentous fungal host cell is a *Mucor* cell. In another preferred embodiment, the filamentous

fungal host cell is a *Neurospora* cell. In another preferred embodiment, the filamentous fungal host cell is a *Penicillium* cell. In another preferred embodiment, the filamentous fungal host cell is a *Thielavia* cell. In another preferred embodiment, the filamentous fungal host cell is a *Tolypocladium* cell. In another preferred embodiment, the filamentous fungal host cell is a *Trichoderma* cell. In a preferred embodiment, the filamentous fungal host cell is an *Aspergillus oryzae* cell, an *Aspergillus niger* cell, an *Aspergillus foetidus* cell, or an *Aspergillus japonicus* cell. In another preferred embodiment, the filamentous fungal host cell is a *Fusarium oxysporum* cell or a *Fusarium graminearum* cell. In another preferred embodiment, the filamentous fungal host cell is a *Humicola insolens* cell or a *Humicola lanuginosus* cell. In another preferred embodiment, the filamentous fungal host cell is a *Myceliophthora thermophila* cell. In a most preferred embodiment, the filamentous fungal host cell is a *Mucor miehei* cell. In a most preferred embodiment, the filamentous fungal host cell is a *Neurospora crassa* cell. In a most preferred embodiment, the filamentous fungal host cell is a *Penicillium purpurogenum* cell. In another most preferred embodiment, the filamentous fungal host cell is a *Thielavia terrestris* cell. In another most preferred embodiment, the *Trichoderma* cell is a *Trichoderma reesei* cell, a *Trichoderma viride* cell, a *Trichoderma longibrachiatum* cell, a *Trichoderma harzianum* cell, or a *Trichoderma koningii* cell. In a preferred embodiment, the fungal host cell is selected from an *A. nidulans* cell, an *A. niger* cell, an *A. oryzae* cell and an *A. sojae* cell. In a further preferred embodiment, the fungal host cell is an *A. nidulans* cell.

The recombinant fungal host cells of the present invention may further comprise one or more sequences which encode one or more factors that are advantageous in the expression of the protein or fragment thereof, for example, an activator (e.g., a trans-acting factor), a chaperone and a processing protease. The nucleic acids encoding one or more of these factors are

preferably not operably linked to the nucleic acid encoding the protein or fragment thereof. An activator is a protein which activates transcription of a nucleic acid sequence encoding a polypeptide (Kudla *et al.*, *EMBO* 9:1355-1364(1990); Jarai and Buxton, *Current Genetics* 26:2238-244(1994); Verdier, *Yeast* 6:271-297(1990), all of which are herein incorporated by reference in their entirety). The nucleic acid sequence encoding an activator may be obtained from the genes encoding *Saccharomyces cerevisiae* heme activator protein 1 (hap1), *Saccharomyces cerevisiae* galactose metabolizing protein 4 (gal4) and *Aspergillus nidulans* ammonia regulation protein (areA). For further examples, see Verdier, *Yeast* 6:271-297 (1990); MacKenzie *et al.*, *Journal of Gen. Microbiol.* 139:2295-2307 (1993), both of which are herein incorporated by reference in their entirety). A chaperone is a protein which assists another protein in folding properly (Hartl *et al.*, *TIBS* 19:20-25 (1994); Bergeron *et al.*, *TIBS* 19:124-128 (1994); Demolder *et al.*, *J. Biotechnology* 32:179-189 (1994); Craig, *Science* 260:1902-1903(1993); Gething and Sambrook, *Nature* 355:33-45 (1992); Puig and Gilbert, *J Biol. Chem.* 269:7764-7771 (1994); Wang and Tsou, *FASEB Journal* 7:1515-11157 (1993); Robinson *et al.*, *Bio/Technology* 1:381-384 (1994), all of which are herein incorporated by reference in their entirety). The nucleic acid sequence encoding a chaperone may be obtained from the genes encoding *Aspergillus oryzae* protein disulphide isomerase, *Saccharomyces cerevisiae* calnexin, *Saccharomyces cerevisiae* BiP/GRP78 and *Saccharomyces cerevisiae* Hsp70. For further examples, see Gething and Sambrook, *Nature* 355:33-45 (1992); Hartl *et al.*, *TIBS* 19:20-25 (1994). A processing protease is a protease that cleaves a propeptide to generate a mature biochemically active polypeptide (Enderlin and Ogrydziak, *Yeast* 10:67-79 (1994); Fuller *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 86:1434-1438 (1989); Julius *et al.*, *Cell* 37:1075-1089 (1984); Julius *et al.*, *Cell* 32:839-852 (1983), all of which are incorporated by reference in their entirety).

The nucleic acid sequence encoding a processing protease may be obtained from the genes encoding *Aspergillus niger* Kex2, *Saccharomyces cerevisiae* dipeptidylaminopeptidase, *Saccharomyces cerevisiae* Kex2 and *Yarrowia lipolytica* dibasic processing endoprotease (xpr6). Any factor that is functional in the fungal host cell of choice may be used in the present invention.

Fungal cells may be transformed by a process involving protoplast formation, transformation of the protoplasts and regeneration of the cell wall in a manner known per se. Suitable procedures for transformation of *Aspergillus* host cells are described in EP 238 023 and Yelton *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 81:1470-1474 (1984), both of which are herein incorporated by reference in their entirety. A suitable method of transforming *Fusarium* species is described by Malardier *et al.*, *Gene* 78:147-156 (1989), the entirety of which is herein incorporated by reference. Yeast may be transformed using the procedures described by Becker and Guarente, In: Abelson and Simon, (eds.), *Guide to Yeast Genetics and Molecular Biology, Methods Enzymol.* Volume 194, pp 182-187, Academic Press, Inc., New York; Ito *et al.*, *J. Bacteriology* 153:163 (1983); Hinnen *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 75:1920 (1978), all of which are herein incorporated by reference in their entirety.

The present invention also relates to methods of producing the protein or fragment thereof comprising culturing the recombinant fungal host cells under conditions conducive for expression of the protein or fragment thereof. The fungal cells of the present invention are cultivated in a nutrient medium suitable for production of the protein or fragment thereof using methods known in the art. For example, the cell may be cultivated by shake flask cultivation, small-scale or large-scale fermentation (including continuous, batch, fed-batch, or solid state fermentations) in laboratory or industrial fermentors performed in a suitable medium and under

conditions allowing the protein or fragment thereof to be expressed and/or isolated. The cultivation takes place in a suitable nutrient medium comprising carbon and nitrogen sources and inorganic salts, using procedures known in the art (*see, e.g.,* Bennett and LaSure (eds.), *More Gene Manipulations in Fungi*, Academic Press, CA, (1991), the entirety of which is herein incorporated by reference). Suitable media are available from commercial suppliers or may be prepared according to published compositions (*e.g.,* in catalogues of the American Type Culture Collection, Manassas, VA). If the protein or fragment thereof is secreted into the nutrient medium, a protein or fragment thereof can be recovered directly from the medium. If the protein or fragment thereof is not secreted, it is recovered from cell lysates.

The expressed protein or fragment thereof may be detected using methods known in the art that are specific for the particular protein or fragment. These detection methods may include the use of specific antibodies, formation of an enzyme product, or disappearance of an enzyme substrate. For example, if the protein or fragment thereof has enzymatic activity, an enzyme assay may be used. Alternatively, if polyclonal or monoclonal antibodies specific to the protein or fragment thereof are available, immunoassays may be employed using the antibodies to the protein or fragment thereof. The techniques of enzyme assay and immunoassay are well known to those skilled in the art.

The resulting protein or fragment thereof may be recovered by methods known in the arts. For example, the protein or fragment thereof may be recovered from the nutrient medium by conventional procedures including, but not limited to, centrifugation, filtration, extraction, spray-drying, evaporation, or precipitation. The recovered protein or fragment thereof may then be further purified by a variety of chromatographic procedures, *e.g.,* ion exchange chromatography, gel filtration chromatography, affinity chromatography, or the like.

(c) Mammalian Constructs and Transformed Mammalian Cells

The present invention also relates to methods for obtaining a recombinant mammalian host cell, comprising introducing into a mammalian host cell exogenous genetic material. The present invention also relates to a mammalian cell comprising a mammalian recombinant vector.

- 5 The present invention also relates to methods for obtaining a recombinant mammalian host cell, comprising introducing into a mammalian cell exogenous genetic material. In a preferred embodiment the exogenous genetic material includes a nucleic acid molecule of the present invention having a sequence selected from the group consisting of SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof or fragments of either or other nucleic acid molecule of the present invention.

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Mammalian cell lines available as hosts for expression are known in the art and include many immortalized cell lines available from the American Type Culture Collection (ATCC, Manassas, VA), such as HeLa cells, Chinese hamster ovary (CHO) cells, baby hamster kidney (BHK) cells and a number of other cell lines. Suitable promoters for mammalian cells are also known in the art and include viral promoters such as that from Simian Virus 40 (SV40) (Fiers *et al.*, *Nature* 273:113 (1978), the entirety of which is herein incorporated by reference), Rous sarcoma virus (RSV), adenovirus (ADV) and bovine papilloma virus (BPV). Mammalian cells may also require terminator sequences and poly-A addition sequences. Enhancer sequences which increase expression may also be included and sequences which promote amplification of the gene may also be desirable (for example methotrexate resistance genes).

Vectors suitable for replication in mammalian cells may include viral replicons, or sequences which insure integration of the appropriate sequences encoding HCV epitopes into the host genome. For example, another vector used to express foreign DNA is vaccinia virus. In this

case, for example, a nucleic acid molecule encoding a protein or fragment thereof is inserted into the vaccinia genome. Techniques for the insertion of foreign DNA into the vaccinia virus genome are known in the art and may utilize, for example, homologous recombination. Such heterologous DNA is generally inserted into a gene which is non-essential to the virus, for example, the thymidine kinase gene (tk), which also provides a selectable marker. Plasmid vectors that greatly facilitate the construction of recombinant viruses have been described (*see*, for example, Mackett *et al*, *J Virol.* 49:857 (1984); Chakrabarti *et al.*, *Mol. Cell. Biol.* 5:3403 (1985); Moss, In: *Gene Transfer Vectors For Mammalian Cells* (Miller and Calos, eds., Cold Spring Harbor Laboratory, N.Y., p. 10, (1987); all of which are herein incorporated by reference in their entirety). Expression of the HCV polypeptide then occurs in cells or animals which are infected with the live recombinant vaccinia virus.

The sequence to be integrated into the mammalian sequence may be introduced into the primary host by any convenient means, which includes calcium precipitated DNA, spheroplast fusion, transformation, electroporation, biolistics, lipofection, microinjection, or other convenient means. Where an amplifiable gene is being employed, the amplifiable gene may serve as the selection marker for selecting hosts into which the amplifiable gene has been introduced.

Alternatively, one may include with the amplifiable gene another marker, such as a drug resistance marker, e.g. neomycin resistance (G418 in mammalian cells), hygromycin in resistance etc., or an auxotrophy marker (HIS3, TRP1, LEU2, URA3, ADE2, LYS2, etc.) for use in yeast cells.

Depending upon the nature of the modification and associated targeting construct, various techniques may be employed for identifying targeted integration. Conveniently, the DNA may be digested with one or more restriction enzymes and the fragments probed with an appropriate

DNA fragment which will identify the properly sized restriction fragment associated with integration.

One may use different promoter sequences, enhancer sequences, or other sequence which will allow for enhanced levels of expression in the expression host. Thus, one may combine an enhancer from one source, a promoter region from another source, a 5'- noncoding region upstream from the initiation methionine from the same or different source as the other sequences and the like. One may provide for an intron in the non-coding region with appropriate splice sites or for an alternative 3'- untranslated sequence or polyadenylation site. Depending upon the particular purpose of the modification, any of these sequences may be introduced, as desired.

Where selection is intended, the sequence to be integrated will have with it a marker gene, which allows for selection. The marker gene may conveniently be downstream from the target gene and may include resistance to a cytotoxic agent, e.g. antibiotics, heavy metals, or the like, resistance or susceptibility to HAT, gancyclovir, etc., complementation to an auxotrophic host, particularly by using an auxotrophic yeast as the host for the subject manipulations, or the like. The marker gene may also be on a separate DNA molecule, particularly with primary mammalian cells. Alternatively, one may screen the various transformants, due to the high efficiency of recombination in yeast, by using hybridization analysis, PCR, sequencing, or the like.

For homologous recombination, constructs can be prepared where the amplifiable gene will be flanked, normally on both sides with DNA homologous with the DNA of the target region. Depending upon the nature of the integrating DNA and the purpose of the integration, the homologous DNA will generally be within 100kb, usually 50kb, preferably about 25kb, of the transcribed region of the target gene, more preferably within 2kb of the target gene. Where

modeling of the gene is intended, homology will usually be present proximal to the site of the mutation. The homologous DNA may include the 5'-upstream region outside of the transcriptional regulatory region or comprising any enhancer sequences, transcriptional initiation sequences, adjacent sequences, or the like. The homologous region may include a portion of the coding region, where the coding region may be comprised only of an open reading frame or combination of exons and introns. The homologous region may comprise all or a portion of an intron, where all or a portion of one or more exons may also be present. Alternatively, the homologous region may comprise the 3'-region, so as to comprise all or a portion of the transcriptional termination region, or the region 3' of this region. The homologous regions may extend over all or a portion of the target gene or be outside the target gene comprising all or a portion of the transcriptional regulatory regions and/or the structural gene.

The integrating constructs may be prepared in accordance with conventional ways, where sequences may be synthesized, isolated from natural sources, manipulated, cloned, ligated, subjected to in vitro mutagenesis, primer repair, or the like. At various stages, the joined sequences may be cloned and analyzed by restriction analysis, sequencing, or the like. Usually during the preparation of a construct where various fragments are joined, the fragments, intermediate constructs and constructs will be carried on a cloning vector comprising a replication system functional in a prokaryotic host, e.g., *E. coli* and a marker for selection, e.g., biocide resistance, complementation to an auxotrophic host, etc. Other functional sequences may also be present, such as polylinkers, for ease of introduction and excision of the construct or portions thereof, or the like. A large number of cloning vectors are available such as pBR322, the pUC series, etc. These constructs may then be used for integration into the primary mammalian host.

In the case of the primary mammalian host, a replicating vector may be used. Usually, such vector will have a viral replication system, such as SV40, bovine papilloma virus, adenovirus, or the like. The linear DNA sequence vector may also have a selectable marker for identifying transfected cells. Selectable markers include the neo gene, allowing for selection with G418, the herpes tk gene for selection with HAT medium, the gpt gene with mycophenolic acid, complementation of an auxotrophic host, etc.

The vector may or may not be capable of stable maintenance in the host. Where the vector is capable of stable maintenance, the cells will be screened for homologous integration of the vector into the genome of the host, where various techniques for curing the cells may be employed. Where the vector is not capable of stable maintenance, for example, where a temperature sensitive replication system is employed, one may change the temperature from the permissive temperature to the non-permissive temperature, so that the cells may be cured of the vector. In this case, only those cells having integration of the construct comprising the amplifiable gene and, when present, the selectable marker, will be able to survive selection.

Where a selectable marker is present, one may select for the presence of the targeting construct by means of the selectable marker. Where the selectable marker is not present, one may select for the presence of the construct by the amplifiable gene. For the neo gene or the herpes tk gene, one could employ a medium for growth of the transformants of about 0.1-1 mg/ml of G418 or may use HAT medium, respectively. Where DHFR is the amplifiable gene, the selective medium may include from about 0.01-0.5 μ M of methotrexate or be deficient in glycine-hypoxanthine-thymidine and have dialysed serum (GHT media).

The DNA can be introduced into the expression host by a variety of techniques that include calcium phosphate/DNA co-precipitates, microinjection of DNA into the nucleus,

electroporation, yeast protoplast fusion with intact cells, transfection, polycations, e.g., polybrene, polyornithine, etc., or the like. The DNA may be single or double stranded DNA, linear or circular. The various techniques for transforming mammalian cells are well known (see Keown *et al.*, *Methods Enzymol.* (1989); Keown *et al.*, *Methods Enzymol.* 185:527-537 (1990); Mansour *et al.*, *Nature* 336:348-352, (1988); all of which are herein incorporated by reference in their entirety).

(d) Insect Constructs and Transformed Insect Cells

The present invention also relates to an insect recombinant vectors comprising exogenous genetic material. The present invention also relates to an insect cell comprising an insect recombinant vector. The present invention also relates to methods for obtaining a recombinant insect host cell, comprising introducing into an insect cell exogenous genetic material. In a preferred embodiment the exogenous genetic material includes a nucleic acid molecule of the present invention having a sequence selected from the group consisting of SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof or fragments of either or other nucleic acid molecule of the present invention.

The insect recombinant vector may be any vector which can be conveniently subjected to recombinant DNA procedures and can bring about the expression of the nucleic acid sequence. The choice of a vector will typically depend on the compatibility of the vector with the insect host cell into which the vector is to be introduced. The vector may be a linear or a closed circular plasmid. The vector system may be a single vector or plasmid or two or more vectors or plasmids which together contain the total DNA to be introduced into the genome of the insect host. In addition, the insect vector may be an expression vector. Nucleic acid molecules can be suitably inserted into a replication vector for expression in the insect cell under a suitable

promoter for insect cells. Many vectors are available for this purpose and selection of the appropriate vector will depend mainly on the size of the nucleic acid molecule to be inserted into the vector and the particular host cell to be transformed with the vector. Each vector contains various components depending on its function (amplification of DNA or expression of DNA) and the particular host cell with which it is compatible. The vector components for insect cell transformation generally include, but are not limited to, one or more of the following: a signal sequence, origin of replication, one or more marker genes and an inducible promoter.

The insect vector may be an autonomously replicating vector, *i.e.*, a vector which exists as an extrachromosomal entity, the replication of which is independent of chromosomal replication, *e.g.*, a plasmid, an extrachromosomal element, a minichromosome, or an artificial chromosome. The vector may contain any means for assuring self-replication. Alternatively, the vector may be one which, when introduced into the insect cell, is integrated into the genome and replicated together with the chromosome(s) into which it has been integrated. For integration, the vector may rely on the nucleic acid sequence of the vector for stable integration of the vector into the genome by homologous or nonhomologous recombination. Alternatively, the vector may contain additional nucleic acid sequences for directing integration by homologous recombination into the genome of the insect host. The additional nucleic acid sequences enable the vector to be integrated into the host cell genome at a precise location(s) in the chromosome(s). To increase the likelihood of integration at a precise location, there should be preferably two nucleic acid sequences which individually contain a sufficient number of nucleic acids, preferably 400bp to 1500bp, more preferably 800bp to 1000bp, which are highly homologous with the corresponding target sequence to enhance the probability of homologous recombination. These nucleic acid sequences may be any sequence that is homologous with a

target sequence in the genome of the insect host cell and, furthermore, may be non-encoding or encoding sequences.

Baculovirus expression vectors (BEVs) have become important tools for the expression of foreign genes, both for basic research and for the production of proteins with direct clinical applications in human and veterinary medicine (Doerfler, *Curr. Top. Microbiol. Immunol.* 131:51-68 (1968); Luckow and Summers, *Bio/Technology* 6:47-55 (1988a); Miller, *Annual Review of Microbiol.* 42:177-199 (1988); Summers, *Curr. Comm. Molecular Biology*, Cold Spring Harbor Press, Cold Spring Harbor, N.Y. (1988); all of which are herein incorporated by reference in their entirety). BEVs are recombinant insect viruses in which the coding sequence for a chosen foreign gene has been inserted behind a baculovirus promoter in place of the viral gene, e.g., polyhedrin (Smith and Summers, U.S. Pat. No., 4,745,051, the entirety of which is incorporated herein by reference).

The use of baculovirus vectors relies upon the host cells being derived from *Lepidopteran* insects such as *Spodoptera frugiperda* or *Trichoplusia ni*. The preferred *Spodoptera frugiperda* cell line is the cell line Sf9. The *Spodoptera frugiperda* Sf9 cell line was obtained from American Type Culture Collection (Manassas, VA.) and is assigned accession number ATCC CRL 1711 (Summers and Smith, *A Manual of Methods for Baculovirus Vectors and Insect Cell Culture Procedures*, Texas Ag. Exper. Station Bulletin No. 1555 (1988), the entirety of which is herein incorporated by reference). Other insect cell systems, such as the silkworm *B. mori* may also be used.

The proteins expressed by the BEVs are, therefore, synthesized, modified and transported in host cells derived from *Lepidopteran* insects. Most of the genes that have been inserted and produced in the baculovirus expression vector system have been derived from vertebrate species.

Other baculovirus genes in addition to the polyhedrin promoter may be employed to advantage in a baculovirus expression system. These include immediate-early (α), delayed-early (β), late (γ), or very late (δ), according to the phase of the viral infection during which they are expressed. The expression of these genes occurs sequentially, probably as the result of a "cascade" mechanism of transcriptional regulation. (Guarino and Summers, *J. Virol.* 57:563-571 (1986); Guarino and Summers, *J. Virol.* 61:2091-2099 (1987); Guarino and Summers, *Virol.* 162:444-451 (1988); all of which are herein incorporated by reference in their entirety).

Insect recombinant vectors are useful as intermediates for the infection or transformation of insect cell systems. For example, an insect recombinant vector containing a nucleic acid molecule encoding a baculovirus transcriptional promoter followed downstream by an insect signal DNA sequence is capable of directing the secretion of the desired biologically active protein from the insect cell. The vector may utilize a baculovirus transcriptional promoter region derived from any of the over 500 baculoviruses generally infecting insects, such as for example the Orders *Lepidoptera*, *Diptera*, *Orthoptera*, *Coleoptera* and *Hymenoptera*, including for example but not limited to the viral DNAs of *Autographa californica* MNPV, *Bombyx mori* NPV, *Trichoplusia ni* MNPV, *Rachiplusia ou* MNPV or *Galleria mellonella* MNPV, wherein said baculovirus transcriptional promoter is a baculovirus immediate-early gene IEL or IEN promoter; an immediate-early gene in combination with a baculovirus delayed-early gene promoter region selected from the group consisting of 39K and a *HindIII-k* fragment delayed-early gene; or a baculovirus late gene promoter. The immediate-early or delayed-early promoters can be enhanced with transcriptional enhancer elements. The insect signal DNA sequence may code for a signal peptide of a *Lepidopteran* adipokinetic hormone precursor or a signal peptide of the *Manduca sexta* adipokinetic hormone precursor (Summers, U.S. Patent No. 5,155,037; the

entirety of which is herein incorporated by reference). Other insect signal DNA sequences include a signal peptide of the *Orthoptera Schistocerca gregaria* locust adipokinetic hormone precursor and the *Drosophila melanogaster* cuticle genes CP1, CP2, CP3 or CP4 or for an insect signal peptide having substantially a similar chemical composition and function (Summers, U.S. Patent No. 5,155,037).

Insect cells are distinctly different from animal cells. Insects have a unique life cycle and have distinct cellular properties such as the lack of intracellular plasminogen activators in which are present in vertebrate cells. Another difference is the high expression levels of protein products ranging from 1 to greater than 500 mg/liter and the ease at which cDNA can be cloned into cells (Frasier, *In Vitro Cell. Dev. Biol.* 25:225 (1989); Summers and Smith, In: *A Manual of Methods for Baculovirus Vectors and Insect Cell Culture Procedures*, Texas Ag. Exper. Station Bulletin No. 1555 (1988), both of which are incorporated by reference in their entirety).

Recombinant protein expression in insect cells is achieved by viral infection or stable transformation. For viral infection, the desired gene is cloned into baculovirus at the site of the wild-type polyhedron gene (Webb and Summers, *Technique* 2:173 (1990); Bishop and Posse, *Adv. Gene Technol.* 1:55 (1990); both of which are incorporated by reference in their entirety).

The polyhedron gene is a component of a protein coat in occlusions which encapsulate virus particles. Deletion or insertion in the polyhedron gene results the failure to form occlusion bodies. Occlusion negative viruses are morphologically different from occlusion positive viruses and enable one skilled in the art to identify and purify recombinant viruses.

The vectors of present invention preferably contain one or more selectable markers which permit easy selection of transformed cells. A selectable marker is a gene the product of which provides, for example biocide or viral resistance, resistance to heavy metals, prototrophy to

auxotrophs and the like. Selection may be accomplished by co-transformation, *e.g.*, as described in WO 91/17243, a nucleic acid sequence of the present invention may be operably linked to a suitable promoter sequence. The promoter sequence is a nucleic acid sequence which is recognized by the insect host cell for expression of the nucleic acid sequence. The promoter sequence contains transcription and translation control sequences which mediate the expression of the protein or fragment thereof. The promoter may be any nucleic acid sequence which shows transcriptional activity in the insect host cell of choice and may be obtained from genes encoding polypeptides either homologous or heterologous to the host cell.

For example, a nucleic acid molecule encoding a protein or fragment thereof may also be operably linked to a suitable leader sequence. A leader sequence is a nontranslated region of a mRNA which is important for translation by the fungal host. The leader sequence is operably linked to the 5' terminus of the nucleic acid sequence encoding the protein or fragment thereof. The leader sequence may be native to the nucleic acid sequence encoding the protein or fragment thereof or may be obtained from foreign sources. Any leader sequence which is functional in the insect host cell of choice may be used in the present invention.

A polyadenylation sequence may also be operably linked to the 3' terminus of the nucleic acid sequence of the present invention. The polyadenylation sequence is a sequence which when transcribed is recognized by the insect host to add polyadenosine residues to transcribed mRNA. The polyadenylation sequence may be native to the nucleic acid sequence encoding the protein or fragment thereof or may be obtained from foreign sources. Any polyadenylation sequence which is functional in the fungal host of choice may be used in the present invention.

To avoid the necessity of disrupting the cell to obtain the protein or fragment thereof and to minimize the amount of possible degradation of the expressed polypeptide within the cell, it is

preferred that expression of the polypeptide gene gives rise to a product secreted outside the cell.

To this end, the protein or fragment thereof of the present invention may be linked to a signal peptide linked to the amino terminus of the protein or fragment thereof. A signal peptide is an amino acid sequence which permits the secretion of the protein or fragment thereof from the

5 insect host into the culture medium. The signal peptide may be native to the protein or fragment thereof of the invention or may be obtained from foreign sources. The 5' end of the coding sequence of the nucleic acid sequence of the present invention may inherently contain a signal peptide coding region naturally linked in translation reading frame with the segment of the coding region which encodes the secreted protein or fragment thereof.

At present, a mode of achieving secretion of a foreign gene product in insect cells is by way of the foreign gene's native signal peptide. Because the foreign genes are usually from non-insect organisms, their signal sequences may be poorly recognized by insect cells and hence, levels of expression may be suboptimal. However, the efficiency of expression of foreign gene products seems to depend primarily on the characteristics of the foreign protein. On average, nuclear localized or non-structural proteins are most highly expressed, secreted proteins are intermediate and integral membrane proteins are the least expressed. One factor generally affecting the efficiency of the production of foreign gene products in a heterologous host system is the presence of native signal sequences (also termed presequences, targeting signals, or leader sequences) associated with the foreign gene. The signal sequence is generally coded by a DNA
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20 sequence immediately following (5' to 3') the translation start site of the desired foreign gene.

The expression dependence on the type of signal sequence associated with a gene product can be represented by the following example: If a foreign gene is inserted at a site downstream from the translational start site of the baculovirus polyhedrin gene so as to produce a fusion

protein (containing the N-terminus of the polyhedrin structural gene), the fused gene is highly expressed. But less expression is achieved when a foreign gene is inserted in a baculovirus expression vector immediately following the transcriptional start site and totally replacing the polyhedrin structural gene.

5 Insertions into the region -50 to -1 significantly alter (reduce) steady state transcription which, in turn, reduces translation of the foreign gene product. Use of the pVL941 vector optimizes transcription of foreign genes to the level of the polyhedrin gene transcription. Even though the transcription of a foreign gene may be optimal, optimal translation may vary because of several factors involving processing: signal peptide recognition, mRNA and ribosome binding, glycosylation, disulfide bond formation, sugar processing, oligomerization, for example.

10 The properties of the insect signal peptide are expected to be more optimal for the efficiency of the translation process in insect cells than those from vertebrate proteins. This phenomenon can generally be explained by the fact that proteins secreted from cells are synthesized as precursor molecules containing hydrophobic N-terminal signal peptides. The signal peptides direct transport of the select protein to its target membrane and are then cleaved by a peptidase on the membrane, such as the endoplasmic reticulum, when the protein passes through it.

15 Another exemplary insect signal sequence is the sequence encoding for *Drosophila* cuticle proteins such as CP1, CP2, CP3 or CP4 (Summers, U.S. Patent No. 5,278,050; the
20 entirety of which is herein incorporated by reference). Most of a 9kb region of the *Drosophila* genome containing genes for the cuticle proteins has been sequenced. Four of the five cuticle genes contains a signal peptide coding sequence interrupted by a short intervening sequence (about 60 base pairs) at a conserved site. Conserved sequences occur in the 5' mRNA

untranslated region, in the adjacent 35 base pairs of upstream flanking sequence and at -200 base pairs from the mRNA start position in each of the cuticle genes.

Standard methods of insect cell culture, cotransfection and preparation of plasmids are set forth in Summers and Smith (Summers and Smith, *A Manual of Methods for Baculovirus Vectors and Insect Cell Culture Procedures*, Texas Agricultural Experiment Station Bulletin No. 1555, Texas A&M University (1987)). Procedures for the cultivation of viruses and cells are described in Volkman and Summers, *J. Virol* 19:820-832 (1975) and Volkman *et al.*, *J. Virol* 19:820-832 (1976); both of which are herein incorporated by reference in their entirety.

(e) Bacterial Constructs and Transformed Bacterial Cells

The present invention also relates to a bacterial recombinant vector comprising exogenous genetic material. The present invention also relates to a bacteria cell comprising a bacterial recombinant vector. The present invention also relates to methods for obtaining a recombinant bacteria host cell, comprising introducing into a bacterial host cell exogenous genetic material. . In a preferred embodiment the exogenous genetic material includes a nucleic acid molecule of the present invention having a sequence selected from the group consisting of SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof or fragments of either or other nucleic acid molecule of the present invention.

The bacterial recombinant vector may be any vector which can be conveniently subjected to recombinant DNA procedures. The choice of a vector will typically depend on the compatibility of the vector with the bacterial host cell into which the vector is to be introduced. The vector may be a linear or a closed circular plasmid. The vector system may be a single vector or plasmid or two or more vectors or plasmids which together contain the total DNA to be introduced into the genome of the bacterial host. In addition, the bacterial vector may be an

expression vector. Nucleic acid molecules encoding protein homologues or fragments thereof can, for example, be suitably inserted into a replicable vector for expression in the bacterium under the control of a suitable promoter for bacteria. Many vectors are available for this purpose and selection of the appropriate vector will depend mainly on the size of the nucleic acid to be inserted into the vector and the particular host cell to be transformed with the vector. Each vector contains various components depending on its function (amplification of DNA or expression of DNA) and the particular host cell with which it is compatible. The vector components for bacterial transformation generally include, but are not limited to, one or more of the following: a signal sequence, an origin of replication, one or more marker genes and an inducible promoter.

In general, plasmid vectors containing replicon and control sequences that are derived from species compatible with the host cell are used in connection with bacterial hosts. The vector ordinarily carries a replication site, as well as marking sequences that are capable of providing phenotypic selection in transformed cells. For example, *E. coli* is typically transformed using pBR322, a plasmid derived from an *E. coli* species (see, e.g., Bolivar *et al.*, *Gene* 2:95 (1977); the entirety of which is herein incorporated by reference). pBR322 contains genes for ampicillin and tetracycline resistance and thus provides easy means for identifying transformed cells. The pBR322 plasmid, or other microbial plasmid or phage, also generally contains, or is modified to contain, promoters that can be used by the microbial organism for expression of the selectable marker genes.

Nucleic acid molecules encoding protein or fragments thereof may be expressed not only directly, but also as a fusion with another polypeptide, preferably a signal sequence or other polypeptide having a specific cleavage site at the N-terminus of the mature polypeptide. In

general, the signal sequence may be a component of the vector, or it may be a part of the polypeptide DNA that is inserted into the vector. The heterologous signal sequence selected should be one that is recognized and processed (i.e., cleaved by a signal peptidase) by the host cell. For bacterial host cells that do not recognize and process the native polypeptide signal sequence, the signal sequence is substituted by a bacterial signal sequence selected, for example, from the group consisting of the alkaline phosphatase, penicillinase, lpp, or heat-stable enterotoxin II leaders.

Both expression and cloning vectors contain a nucleic acid sequence that enables the vector to replicate in one or more selected host cells. Generally, in cloning vectors this sequence is one that enables the vector to replicate independently of the host chromosomal DNA and includes origins of replication or autonomously replicating sequences. Such sequences are well known for a variety of bacteria. The origin of replication from the plasmid pBR322 is suitable for most Gram-negative bacteria.

Expression and cloning vectors also generally contain a selection gene, also termed a selectable marker. This gene encodes a protein necessary for the survival or growth of transformed host cells grown in a selective culture medium. Host cells not transformed with the vector containing the selection gene will not survive in the culture medium. Typical selection genes encode proteins that (a) confer resistance to antibiotics or other toxins, e.g., ampicillin, neomycin, methotrexate, or tetracycline, (b) complement auxotrophic deficiencies, or (c) supply critical nutrients not available from complex media, e.g., the gene encoding D-alanine racemase for *Bacilli*. One example of a selection scheme utilizes a drug to arrest growth of a host cell. Those cells that are successfully transformed with a heterologous protein homologue or fragment thereof produce a protein conferring drug resistance and thus survive the selection regimen.

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The expression vector for producing a protein or fragment thereof can also contains an inducible promoter that is recognized by the host bacterial organism and is operably linked to the nucleic acid encoding, for example, the nucleic acid molecule encoding the protein homologue or fragment thereof of interest. Inducible promoters suitable for use with bacterial hosts include the β -lactamase and lactose promoter systems (Chang *et al.*, *Nature* 275:615 (1978); Goeddel *et al.*, *Nature* 281:544 (1979); both of which are herein incorporated by reference in their entirety), the arabinose promoter system (Guzman *et al.*, *J. Bacteriol.* 174:7716-7728 (1992); the entirety of which is herein incorporated by reference), alkaline phosphatase, a tryptophan (trp) promoter system (Goeddel, *Nucleic Acids Res.* 8:4057 (1980); EP 36,776; both of which are herein incorporated by reference in their entirety) and hybrid promoters such as the tac promoter (deBoer *et al.*, *Proc. Natl. Acad. Sci. (USA)* 80:21-25 (1983); the entirety of which is herein incorporated by reference). However, other known bacterial inducible promoters are suitable (Siebenlist *et al.*, *Cell* 20:269 (1980); the entirety of which is herein incorporated by reference).

Promoters for use in bacterial systems also generally contain a Shine-Dalgarno (S.D.) sequence operably linked to the DNA encoding the polypeptide of interest. The promoter can be removed from the bacterial source DNA by restriction enzyme digestion and inserted into the vector containing the desired DNA.

Construction of suitable vectors containing one or more of the above-listed components employs standard ligation techniques. Isolated plasmids or DNA fragments are cleaved, tailored and re-ligated in the form desired to generate the plasmids required. Examples of available bacterial expression vectors include, but are not limited to, the multifunctional *E. coli* cloning and expression vectors such as Bluescript™ (Stratagene, La Jolla, CA), in which, for example,

encoding an *A. nidulans* protein homologue or fragment thereof homologue, may be ligated into the vector in frame with sequences for the amino-terminal Met and the subsequent 7 residues of β -galactosidase so that a hybrid protein is produced; pIN vectors (Van Heeke and Schuster, *J. Biol. Chem.* 264:5503-5509 (1989), the entirety of which is herein incorporated by reference);
5 and the like. pGEX vectors (Promega, Madison Wisconsin U.S.A.) may also be used to express foreign polypeptides as fusion proteins with glutathione S-transferase (GST). In general, such fusion proteins are soluble and can easily be purified from lysed cells by adsorption to glutathione-agarose beads followed by elution in the presence of free glutathione. Proteins made in such systems are designed to include heparin, thrombin or factor XA protease cleavage sites so that the cloned polypeptide of interest can be released from the GST moiety at will.

Suitable host bacteria for a bacterial vector include archaebacteria and eubacteria, especially eubacteria and most preferably *Enterobacteriaceae*. Examples of useful bacteria include *Escherichia*, *Enterobacter*, *Azotobacter*, *Erwinia*, *Bacillus*, *Pseudomonas*, *Klebsiella*, *Proteus*, *Salmonella*, *Serratia*, *Shigella*, *Rhizobia*, *Vitreoscilla* and *Paracoccus*. Suitable *E. coli* hosts include *E. coli* W3110 (American Type Culture Collection (ATCC) 27,325, Manassas, Virginia U.S.A.), *E. coli* 294 (ATCC 31,446), *E. coli* B and *E. coli* X1776 (ATCC 31,537).
15 These examples are illustrative rather than limiting. Mutant cells of any of the above-mentioned bacteria may also be employed. It is, of course, necessary to select the appropriate bacteria taking into consideration replicability of the replicon in the cells of a bacterium. For example, *E.*
20 *coli*, *Serratia*, or *Salmonella* species can be suitably used as the host when well known plasmids such as pBR322, pBR325, pACYC177, or pKN410 are used to supply the replicon. *E. coli* strain W3110 is a preferred host or parent host because it is a common host strain for recombinant

DNA product fermentations. Preferably, the host cell should secrete minimal amounts of proteolytic enzymes.

Host cells are transfected and preferably transformed with the above-described vectors and cultured in conventional nutrient media modified as appropriate for inducing promoters, selecting transformants, or amplifying the genes encoding the desired sequences.

Numerous methods of transfection are known to the ordinarily skilled artisan, for example, calcium phosphate and electroporation. Depending on the host cell used, transformation is done using standard techniques appropriate to such cells. The calcium treatment employing calcium chloride, as described in section 1.82 of Sambrook *et al.*, *Molecular Cloning: A Laboratory Manual*, New York: Cold Spring Harbor Laboratory Press, (1989), is generally used for bacterial cells that contain substantial cell-wall barriers. Another method for transformation employs polyethylene glycol/DMSO, as described in Chung and Miller (Chung and Miller, *Nucleic Acids Res.* 16:3580 (1988); the entirety of which is herein incorporated by reference). Yet another method is the use of the technique termed electroporation.

Bacterial cells used to produce the polypeptide of interest for purposes of this invention are cultured in suitable media in which the promoters for the nucleic acid encoding the heterologous polypeptide can be artificially induced as described generally, e.g., in Sambrook *et al.*, *Molecular Cloning: A Laboratory Manual*, New York: Cold Spring Harbor Laboratory Press, (1989). Examples of suitable media are given in U.S. Pat. Nos. 5,304,472 and 5,342,763; both of which are incorporated by reference in their entirety.

In addition to the above discussed procedures, practitioners are familiar with the standard resource materials which describe specific conditions and procedures for the construction,

manipulation and isolation of macromolecules (e.g., DNA molecules, plasmids, etc.), generation of recombinant organisms and the screening and isolating of clones, (see for example, Sambrook *et al.*, *Molecular Cloning: A Laboratory Manual*, Cold Spring Harbor Press (1989); Mailga *et al.*, *Methods in Plant Molecular Biology*, Cold Spring Harbor Press (1995), the entirety of which is herein incorporated by reference; Birren *et al.*, *Genome Analysis: Analyzing DNA*, 1, Cold Spring Harbor, New York, the entirety of which is herein incorporated by reference).

(f) Computer Readable Media

The nucleotide sequence provided in SEQ ID NO: 1 through SEQ ID NO: 627 or fragment thereof, or complement thereof, or a nucleotide sequence at least 90% identical, preferably 95%, identical even more preferably 99% or 100% identical to the sequence provided in SEQ ID NO: 1 through SEQ ID NO: 627 or fragment thereof, or complement thereof, can be “provided” in a variety of mediums to facilitate use. Such a medium can also provide a subset thereof in a form that allows a skilled artisan to examine the sequences.

A preferred subset of nucleotide sequences are those nucleic acid sequences that encode a first nucleic acid molecule selected from the group consisting of a nucleic acid molecule that encodes a maize or soybean copalyl diphosphate synthase enzyme or complement thereof or fragment of either, a nucleic acid molecule that encodes a maize or soybean deoxyarabiono-heptulosonate-P-synthase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean putative deoxyarabiono-heptulosonate-P-synthase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize dehydroquinase synthase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a soybean dehydroquinase dehydratase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize putative

dehydroquinase dehydratase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean shikimate dehydrogenase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean shikimate kinase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize enolpyruvylshikimate-P-synthase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean chorismate synthase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean chorismate mutase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize tyrosine transaminase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean putative tyrosine transaminase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean transaminase A enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a soybean putative transaminase A enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean 4-hydroxyphenylpyruvate dioxygenase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean homogentisic acid dioxygenase enzyme or complement thereof or fragment of either; and a nucleic acid molecule that encodes a maize or soybean geranylgeranylpyrophosphate synthase enzyme or complement thereof or fragment of either.

A further preferred subset of nucleic acid sequences is where the subset of sequences which encode two proteins or fragments thereof, more preferably three proteins or fragments thereof, more preferably four proteins or fragments thereof, more preferably four proteins or fragments thereof, more preferably five proteins or fragments thereof, more preferably six

proteins or fragments thereof, more preferably seven proteins or fragments thereof, more
 preferably eight proteins or fragments thereof, more preferably nine proteins or fragments
 thereof, more preferably ten proteins or fragments thereof, more preferably eleven proteins or
 fragments thereof, more preferably twelve proteins or fragments thereof, more preferably thirteen
 5 proteins or fragments thereof, more preferably fourteen proteins or fragments thereof, more
 preferably fifteen proteins or fragments thereof, more preferably sixteen proteins or fragments
 thereof, and even more preferably seventeen proteins or fragments thereof. These nucleic acid
 sequences are selected from the group that encodes a maize or soybean copalyl diphosphate
 synthase enzyme or complement thereof or fragment of either, a nucleic acid molecule that
 10 encodes a maize or soybean deoxyarabiono-heptulosonate-P-synthase enzyme or complement
 thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean putative
 deoxyarabiono-heptulosonate-P-synthase enzyme or complement thereof or fragment of either; a
 nucleic acid molecule that encodes a maize dehydroquinate synthase enzyme or complement
 thereof or fragment of either; a nucleic acid molecule that encodes a soybean dehydroquinate
 15 dehydratase enzyme or complement thereof or fragment of either; a nucleic acid molecule that
 encodes a maize putative dehydroquinate dehydratase enzyme or complement thereof or
 fragment of either; a nucleic acid molecule that encodes a maize or soybean shikimate
 dehydrogenase enzyme or complement thereof or fragment of either; a nucleic acid molecule
 that encodes a maize or soybean shikimate kinase enzyme or complement thereof or fragment of
 20 either; a nucleic acid molecule that encodes a maize enolpyruvylshikimate-P-synthase enzyme or
 complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or
 soybean chorismate synthase enzyme or complement thereof or fragment of either; a nucleic acid
 molecule that encodes a maize or soybean chorismate mutase enzyme or complement thereof or

fragment of either; a nucleic acid molecule that encodes a maize tyrosine transaminase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean putative tyrosine transaminase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean transaminase A enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a soybean putative transaminase A enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean 4-hydroxyphenylpyruvate dioxygenase enzyme or complement thereof or fragment of either; a nucleic acid molecule that encodes a maize or soybean homogentisic acid dioxygenase enzyme or complement thereof or fragment of either; and a nucleic acid molecule that encodes a maize or soybean geranylgeranylpyrophosphate synthase enzyme or complement thereof or fragment of either.

In one application of this embodiment, a nucleotide sequence of the present invention can be recorded on computer readable media. As used herein, "computer readable media" refers to any medium that can be read and accessed directly by a computer. Such media include, but are not limited to: magnetic storage media, such as floppy discs, hard disc, storage medium and magnetic tape; optical storage media such as CD-ROM; electrical storage media such as RAM and ROM; and hybrids of these categories such as magnetic/optical storage media. A skilled artisan can readily appreciate how any of the presently known computer readable mediums can be used to create a manufacture comprising computer readable medium having recorded thereon a nucleotide sequence of the present invention.

As used herein, "recorded" refers to a process for storing information on computer readable medium. A skilled artisan can readily adopt any of the presently known methods for recording information on computer readable medium to generate media comprising the

nucleotide sequence information of the present invention. A variety of data storage structures are available to a skilled artisan for creating a computer readable medium having recorded thereon a nucleotide sequence of the present invention. The choice of the data storage structure will generally be based on the means chosen to access the stored information. In addition, a variety of data processor programs and formats can be used to store the nucleotide sequence information of the present invention on computer readable medium. The sequence information can be represented in a word processing text file, formatted in commercially-available software such as WordPerfect and Microsoft Word, or represented in the form of an ASCII file, stored in a database application, such as DB2, Sybase, Oracle, or the like. A skilled artisan can readily adapt any number of data processor structuring formats (e.g. text file or database) in order to obtain computer readable medium having recorded thereon the nucleotide sequence information of the present invention.

By providing one or more of nucleotide sequences of the present invention, a skilled artisan can routinely access the sequence information for a variety of purposes. Computer software is publicly available which allows a skilled artisan to access sequence information provided in a computer readable medium. The examples which follow demonstrate how software which implements the BLAST (Altschul *et al.*, *J. Mol. Biol.* 215:403-410 (1990), the entirety of which is herein incorporated by reference) and BLAZE (Brutlag *et al.*, *Comp. Chem.* 17:203-207 (1993), the entirety of which is herein incorporated by reference) search algorithms on a Sybase system can be used to identify open reading frames (ORFs) within the genome that contain homology to ORFs or proteins from other organisms. Such ORFs are protein-encoding fragments within the sequences of the present invention and are useful in producing commercially important proteins such as enzymes used in amino acid biosynthesis, metabolism,

transcription, translation, RNA processing, nucleic acid and a protein degradation, protein modification and DNA replication, restriction, modification, recombination and repair.

The present invention further provides systems, particularly computer-based systems, which contain the sequence information described herein. Such systems are designed to identify commercially important fragments of the nucleic acid molecule of the present invention. As used herein, "a computer-based system" refers to the hardware means, software means and data storage means used to analyze the nucleotide sequence information of the present invention. The minimum hardware means of the computer-based systems of the present invention comprises a central processing unit (CPU), input means, output means and data storage means. A skilled artisan can readily appreciate that any one of the currently available computer-based system are suitable for use in the present invention.

As indicated above, the computer-based systems of the present invention comprise a data storage means having stored therein a nucleotide sequence of the present invention and the necessary hardware means and software means for supporting and implementing a search means. As used herein, "data storage means" refers to memory that can store nucleotide sequence information of the present invention, or a memory access means which can access manufactures having recorded thereon the nucleotide sequence information of the present invention. As used herein, "search means" refers to one or more programs which are implemented on the computer-based system to compare a target sequence or target structural motif with the sequence information stored within the data storage means. Search means are used to identify fragments or regions of the sequence of the present invention that match a particular target sequence or target motif. A variety of known algorithms are disclosed publicly and a variety of commercially available software for conducting search means are available can be used in the computer-based

systems of the present invention. Examples of such software include, but are not limited to, MacPattern (EMBL), BLASTIN and BLASTIX (NCBIA). One of the available algorithms or implementing software packages for conducting homology searches can be adapted for use in the present computer-based systems.

5 The most preferred sequence length of a target sequence is from about 10 to 100 amino acids or from about 30 to 300 nucleotide residues. However, it is well recognized that during searches for commercially important fragments of the nucleic acid molecules of the present invention, such as sequence fragments involved in gene expression and protein processing, may be of shorter length.

10 As used herein, "a target structural motif," or "target motif," refers to any rationally selected sequence or combination of sequences in which the sequences the sequence(s) are chosen based on a three-dimensional configuration which is formed upon the folding of the target motif. There are a variety of target motifs known in the art. Protein target motifs include, but are not limited to, enzymatic active sites and signal sequences. Nucleic acid target motifs include, but are not limited to, promoter sequences, *cis* elements, hairpin structures and inducible expression elements (protein binding sequences).

15 Thus, the present invention further provides an input means for receiving a target sequence, a data storage means for storing the target sequences of the present invention sequence identified using a search means as described above and an output means for outputting the
20 identified homologous sequences. A variety of structural formats for the input and output means can be used to input and output information in the computer-based systems of the present invention. A preferred format for an output means ranks fragments of the sequence of the present invention by varying degrees of homology to the target sequence or target motif. Such

presentation provides a skilled artisan with a ranking of sequences which contain various amounts of the target sequence or target motif and identifies the degree of homology contained in the identified fragment.

A variety of comparing means can be used to compare a target sequence or target motif with the data storage means to identify sequence fragments sequence of the present invention. For example, implementing software which implement the BLAST and BLAZE algorithms (Altschul *et al.*, *J. Mol. Biol.* 215:403-410 (1990)) can be used to identify open frames within the nucleic acid molecules of the present invention. A skilled artisan can readily recognize that any one of the publicly available homology search programs can be used as the search means for the computer-based systems of the present invention.

Having now generally described the invention, the same will be more readily understood through reference to the following examples which are provided by way of illustration and are not intended to be limiting of the present invention, unless specified.

Example 1

The MONN01 cDNA library is a normalized library generated from maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) total leaf tissue at the V6 plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in

the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected when the maize plant is at the 6-leaf development stage. The older, more juvenile leaves, which are in a basal position, as well as the younger, more adult leaves, which are more apical are cut at the base of the leaves. The leaves are then pooled and immediately transferred to liquid nitrogen containers in which the pooled leaves are crushed. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON001 cDNA library is generated from maize (B73, Illinois Foundation Seeds, Champaign, Illinois U.S.A.) immature tassels at the V6 plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in a greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue from the maize plant is collected at the V6 stage. At that stage the tassel is an immature tassel of about 2-3 cm in length. The tassels are removed and frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON003 library is generated from maize (B73 x Mo17, Illinois Foundation Seeds, Champaign, Illinois U.S.A.) roots at the V6 developmental stage. Seeds are planted at a depth of approximately 3 cm in coil into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth, the seedlings are transplanted into 10 inch pots containing the Metro 200 growing medium. Plants are watered daily before transplantation and approximately 3 times a week after transplantation. Peters 15-16-17 fertilizer is applied approximately three times per week after transplanting at a concentration of 150 ppm N. Two to three times during the life time of the plant from transplanting to flowering a total of approximately 900 mg Fe is added to each pot. Maize plants are grown in the green house in approximately 15hr day/9hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected when the maize plant is at the 6 leaf development stage. The root system is cut from maize plant and washed with water to free it from the soil. The tissue is then immediately frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON004 cDNA library is generated from maize (B73 x Mo17, Illinois Foundation Seeds, Champaign, Illinois U.S.A.) total leaf tissue at the V6 plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are

grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected when the maize plant is at the 6-leaf development stage. The older, more juvenile leaves, which are in a basal position, as well as the younger, more adult leaves, which are more apical are cut at the base of the leaves. The leaves are then pooled and immediately transferred to liquid nitrogen containers in which the pooled leaves are crushed. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON005 cDNA library is generated from maize (B73 x Mo17, Illinois Foundation Seeds, Champaign Illinois, U.S.A.) root tissue at the V6 development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the green house in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected when the maize plant is at the 6-leaf development stage. The root system is cut from the mature maize plant and washed with water to free it from the soil. The tissue is immediately frozen in liquid nitrogen and the harvested tissue is then

stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON006 cDNA library is generated from maize (B73 x Mo17, Illinois Foundation Seeds, Champaign Illinois, U.S.A.) total leaf tissue at the V6 plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected when the maize plant is at the 6-leaf development stage. The older more juvenile leaves, which are in a basal position, as well as the younger more adult leaves, which are more apical are cut at the base of the leaves. The leaves are then pooled and immediately transferred to liquid nitrogen containers in which the pooled leaves are crushed. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON007 cDNA library is generated from the primary root tissue of 5 day old maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) seedlings. Seeds are planted on a moist filter paper on a covered tray that is kept in the dark until germination (one day). After

germination, the trays, along with the moist paper, are moved to a greenhouse where the maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles for approximately 5 days. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. The primary root tissue is collected when the seedlings are 5 days old. At this stage, the primary root (radicle) is pushed through the coleorhiza which itself is pushed through the seed coat. The primary root, which is about 2-3 cm long, is cut and immediately frozen in liquid nitrogen and then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON008 cDNA library is generated from the primary shoot (coleoptile 2-3 cm) of maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) seedlings which are approximately 5 days old. Seeds are planted on a moist filter paper on a covered tray that is kept in the dark until germination (one day). Then the trays containing the seeds are moved to a greenhouse at 15hr daytime/9 hr nighttime cycles and grown until they are 5 days post germination. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Tissue is collected when the seedlings are 5 days old. At this stage, the primary shoot (coleoptile) is pushed through the seed coat and is about 2-3 cm long. The coleoptile is dissected away from the rest of the seedling, immediately frozen in liquid nitrogen and then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON009 cDNA library is generated from maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) leaves at the 8 leaf stage (V8 plant development stage). Seeds are

planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the green house in 15 hr day/9 hr night cycles. The daytime temperature is 80°F and the nighttime temperature is 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected when the maize plant is at the 8-leaf development stage. The older more juvenile leaves, which are in a basal position, as well as the younger more adult leaves, which are more apical, are cut at the base of the leaves. The leaves are then pooled and then immediately transferred to liquid nitrogen containers in which the pooled leaves are crushed. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON010 cDNA library is generated from maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) root tissue at the V8 plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the green house

in 15 hr day/9 hr night cycles. The daytime temperature is 80°F and the nighttime temperature is 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected when the maize plant is at the V8 development stage. The root system is cut from this mature maize plant and washed with water to free it from the soil. The tissue is immediately frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON011 cDNA library is generated from undeveloped maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) leaf at the V6 plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the green house in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected when the maize plant is at the 6-leaf development stage. The second youngest leaf which is at the base of the apical leaf of V6 stage maize plant is cut at the base and immediately transferred to liquid nitrogen containers in which the leaf is crushed. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON012 cDNA library is generated from 2 day post germination maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) seedlings. Seeds are planted on a moist filter paper on a covered tray that is kept in the dark until germination (one day). Then the trays containing the seeds are moved to the greenhouse and grown at 15hr daytime/9 hr nighttime cycles until 2 days post germination. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Tissue is collected when the seedlings are 2 days old. At the two day stage, the coleorhiza is pushed through the seed coat and the primary root (the radicle) is pierced the coleorhiza but is barely visible. Also, at this two day stage, the coleoptile is just emerging from the seed coat. The 2 days post germination seedlings are then immersed in liquid nitrogen and crushed. The harvested tissue is stored at -80°C until preparation of total RNA. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON013 cDNA library is generated from apical maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) meristem founder at the V4 plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000

W sodium vapor lamps. Prior to tissue collection, the plant is at the 4 leaf stage. The lead at the apex of the V4 stage maize plant is referred to as the meristem founder. This apical meristem founder is cut, immediately frozen in liquid nitrogen and crushed. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON014 cDNA library is generated from maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) endosperm fourteen days after pollination. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. After the V10 stage, the maize plant ear shoots are ready for fertilization. At this stage, the ear shoots are enclosed in a paper bag before silk emergence to withhold the pollen. The ear shoots are pollinated and 14 days after pollination, the ears are pulled out and then the kernels are plucked out of the ears. Each kernel is then dissected into the embryo and the endosperm and the aleurone layer is removed. After dissection, the endosperms are immediately frozen in liquid nitrogen and then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON016 library is a maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) sheath library collected at the V8 developmental stage. Seeds are planted in a depth of approximately 3 cm in solid into 2-3 inch pots containing Metro growing medium. After 2-3 weeks growth, they are transplanted into 10" pots containing the same. Plants are watered daily before transplantation and approximately the times a week after transplantation. Peters 15-16-17 fertilizer is applied approximately three times per week after transplanting, at a strength of 150 ppm N. Two to three times during the life time of the plant from transplanting to flowering, a total of approximately 900 mg Fe is added to each pot. Maize plants are grown in the green house in 15hr day/9hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. When the maize plants are at the V8 stage the 5th and 6th leaves from the bottom exhibit fully developed leaf blades. At the base of these leaves, the ligule is differentiated and the leaf blade is joined to the sheath. The sheath is dissected away from the base of the leaf then the sheath is frozen in liquid nitrogen and crushed. The tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON017 cDNA library is generated from maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) embryo seventeen days after pollination. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth the seeds are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a

total of 900 mg Fe is added to each pot. Maize plants are grown in the green house in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. After the V10 stage, the ear shoots of maize plant, which are ready for fertilization, are enclosed in a paper bag before silk emergence to withhold the pollen. The ear shoots are fertilized and 21 days after pollination, the ears are pulled out and the kernels are plucked out of the ears. Each kernel is then dissected into the embryo and the endosperm and the aleurone layer is removed. After dissection, the embryos are immediately frozen in liquid nitrogen and then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON019 (Lib3054) cDNA library is generated from maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) culm (stem) at the V8 developmental stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the green house in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. When the maize plant is at the V8 stage, the 5th and 6th leaves from the bottom have fully developed leaf blades. The region between the nodes of the 5th and the sixth leaves from

the bottom is the region of the stem that is collected. The leaves are pulled out and the sheath is also torn away from the stem. This stem tissue is completely free of any leaf and sheath tissue. The stem tissue is then frozen in liquid nitrogen and stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in

5 Example 2.

The SATMON020 cDNA library is from a maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) Hill Type II-Initiated Callus. Petri plates containing approximately 25 ml of Type II initiation media are prepared. This medium contains N6 salts and vitamins, 3% sucrose, 2.3 g/liter proline 0.1 g/liter enzymatic casein hydrolysate, 2mg/liter 2,4 – dichloro phenoxy-acetic acid (2,4, D), 15.3 mg/liter AgNO₃ and 0.8% bacto agar and is adjusted to pH 6.0 before autoclaving. At 9-11 days after pollination, an ear with immature embryos measuring approximately 1-2 mm in length is chosen. The husks and silks are removed and then the ear is broken into halves and placed in an autoclaved solution of Clorox/TWEEN 20 sterilizing solution. Then the ear is rinsed with deionized water. Then each embryo is extracted from the kernel. Intact embryos are placed in contact with the medium, scutellar side up). Multiple embryos are plated on each plate and the plates are incubated in the dark at 25°C. Type II calluses are friable, can be subcultured with a spatula, frequently regenerate via somatic embryogenesis and are relatively undifferentiated. As seen in the microscope, the Tape II calluses show color ranging from translucent to light yellow and heterogeneity on with respect to embryoid structure as well as stage of embryoid development. Once Type II callus are formed, the calluses is transferred to type II callus maintenance medium without AgNO₃. Every 7-10 days, the callus is subcultured. About 4 weeks after embryo isolation the callus is removed from

the plates and then frozen in liquid nitrogen. The harvested tissue is stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON021 cDNA library is generated from the immature maize (DK604, Dekalb Genetics, Dekalb Illinois, U.S.A.) tassel at the V8 plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the green house in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F . Supplemental lighting is provided by 1000 W sodium vapor lamps. As the maize plant enters the V8 stage, tassels which are 15-20 cm in length are collected and frozen in liquid nitrogen. The harvested tissue is stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON022 cDNA library is generated from maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) ear (growing silks) at the V8 plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after

transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected when the plant is in the V8 stage. At this stage, some immature ear shoots are visible. The immature ear shoots (approximately 1 cm in length) are pulled out, frozen in liquid nitrogen and then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON23 cDNA library is generated from maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) ear (growing silk) at the V8 development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. When the tissue is harvested at the V8 stage, the length of the ear that is harvested is about 10-15 cm and the silks are just exposed (approximately 1 inch). The ear along with the silks is frozen in liquid nitrogen and then the tissue is stored at -80°C until

RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON024 cDNA library is generated from the immature maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) tassel at the V9 development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the green house in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. As a maize plant enters the V9 stage, the tassel is rapidly developing and a 37 cm tassel along with the glume, anthers and pollen is collected and frozen in liquid nitrogen. The harvested tissue is stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON025 cDNA library is from maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) Hill Type II-Regenerated Callus. Type II callus is grown in initiation media as described for SATMON020 and then the embryoids on the surface of the Type II callus are allowed to mature and germinate. The 1-2 gm fresh weight of the soft friable type callus containing numerous embryoids are transferred to 100 x 15 mm petri plates containing 25 ml of regeneration media. Regeneration media consists of Murashige and Skoog (MS) basal salts, modified White's vitamins (0.2 g/liter glycine and 0.5 g/liter myo-inositol and 0.8% bacto agar

(6SMS0D)). The plates are then placed in the dark after covering with parafilm. After 1 week, the plates are moved to a lighted growth chamber with 16 hr light and 8 hr dark photoperiod. Three weeks after plating the Type II callus to 6SMS0D, the callus exhibit shoot formation. The callus and the shoots are transferred to fresh 6SMS0D plates for another 2 weeks. The callus and the shoots are then transferred to petri plates with reduced sucrose (3SMS0D). Upon distinct formation of a root and shoot, the newly developed green plants are then removed out with a spatula and frozen in liquid nitrogen containers. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON026 cDNA library is generated from maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) juvenile/adult shift leaves at the V8 plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the green house in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F . Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected when the maize plants are at the 8-leaf development stage. Leaves are founded sequentially around the meristem over weeks of time and the older, more juvenile leaves arise earlier and in a more basal position than the younger, more adult leaves, which are in a

more apical position. In a V8 plant, some leaves which are in the middle portion of the plant exhibit characteristics of both juvenile as well as adult leaves. They exhibit a yellowing color but also exhibit, in part, a green color. These leaves are termed juvenile/adult shift leaves. The juvenile/adult shift leaves (the 4th, 5th leaves from the bottom) are cut at the base, pooled and transferred to liquid nitrogen in which they are then crushed. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON027 cDNA library is generated from 6 day maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) leaves. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the Metro 200 growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Prior to tissue collection, when the plant is at the 8-leaf stage, water is held back for six days. The older, more juvenile leaves, which are in a basal position, as well as the younger, more adult leaves, which are more apical, are all cut at the base of the leaves. All the leaves exhibit significant wilting. The leaves are then pooled and immediately transferred to liquid nitrogen containers in which the pooled leaves are then crushed. The harvested tissue is then stored at -80°C until RNA

preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON028 cDNA library is generated from maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) roots at the V8 developmental stage that are subject to six days water stress. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the Metro 200 growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Prior to tissue collection, when the plant is at the 8-leaf stage, water is held back for six days. The root system is cut, shaken and washed to remove soil. Root tissue is then pooled and immediately transferred to liquid nitrogen containers in which the pooled leaves are then crushed. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON029 cDNA library is generated from maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) seedlings at the etiolated stage. Seeds are planted on a moist filter paper on a covered tray that is kept in the dark for 4 days at approximately 70°F. Tissue is collected when the seedlings are 4 days old. By 4 days, the primary root has penetrated the coleorhiza and

is about 4-5 cm and the secondary lateral roots have also made their appearance. The coleoptile has also pushed through the seed coat and is about 4-5 cm long. The seedlings are frozen in liquid nitrogen and crushed. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

5 The SATMON030 cDNA library is generated from maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) root tissue at the V4 plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth, they are transplanted into 10 inch pots containing the same. Plants are watered daily before transplantation and approximately 3 times a week after transplantation. Peters 15-16-17 fertilizer is applied approximately three times per week after transplanting, at a strength of 150 ppm N. Two to three times during the life time of the plant, from transplanting to flowering, a total of approximately 900 mg Fe is added to each pot. Maize plants are grown in the green house in 15hr day/9hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 sodium vapor lamps. Tissue is collected when the maize plant is at the 4 leaf development stage. The root system is cut from the mature maize plant and washed with water to free it from the soil. The tissue is then immediately frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

20 The SATMON031 cDNA library is generated from the maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) leaf tissue at the V4 plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium.

After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the green house in 15 hr day/9 hr night cycles. The daytime temperature is 80°F and the nighttime temperature is 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected when the maize plant is at the 4-leaf development stage. The third leaf from the bottom is cut at the base and immediately frozen in liquid nitrogen and crushed. The tissue is immediately frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON033 cDNA library is generated from maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) embryo tissue 13 days after pollination. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. After the V10 stage, the ear shoots of the maize plant, which are ready for fertilization, are enclosed in

a paper bag before silk emergent to withhold the pollen. The ear shoots are pollinated and 13 days after pollination, the ears are pulled out and then the kernels are plucked cut of the ears. Each kernel is then dissected into the embryo and the endosperm and the aleurone layer is removed. After dissection, the embryos are immediately frozen in liquid nitrogen and then
5 stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON034 cDNA library is generated from cold stressed maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) seedlings. Seeds are planted on a moist filter paper on a covered tray that is kept on at 10°C for 7 days. After 7 days, the temperature is shifted to 15°C for one day until germination of the seed. Tissue is collected once the seedlings are 1 day old. At this point, the coleorhiza has just pushed out of the seed coat and the primary root is just making its appearance. The coleoptile has not yet pushed completely through the seed coat and is also just making its appearance. These 1 day old cold stressed seedlings are frozen in liquid nitrogen and crushed. The harvested tissue is then stored at -80°C until RNA preparation. The
10 RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMON~001 (Lib36, Lib83, Lib84) cDNA library is generated from maize leaves at the V8 plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are
20 transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times

during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in a greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F.

Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue from the maize plant

5 is collected at the V8 stage. The older more juvenile leaves in a basal position as well as the younger more adult leaves which are more apical are all cut at the base, pooled and frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SATMONN01 cDNA library is generated from maize (B73, Illinois Foundation Seeds, Champaign, Illinois U.S.A.) normalized immature tassels at the V6 plant development stage normalized tissue. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplanted and three times a week after transplanted. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in a greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F.

Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue from the maize plant

20 is collected at the V6 stage. At that stage the tassel is an immature tassel of about 2-3 cm in length. The tassels are removed and frozen in liquid nitrogen. The harvested tissue is then

stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the normalized cDNA library is constructed as described in Example 2.

The SATMONN04 cDNA library is generated from maize (B73 x Mo17, Illinois Foundation Seeds, Champaign, Illinois U.S.A.) normalized total leaf tissue at the V6 plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected when the maize plant is at the 6-leaf development stage. The older, more juvenile leaves, which are in a basal position, as well as the younger, more adult leaves, which are more apical are cut at the base of the leaves. The leaves are then pooled and immediately transferred to liquid nitrogen containers in which the pooled leaves are crushed. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the normalized cDNA library is constructed as described in Example 2.

The SATMONN05 cDNA library is generated from maize (B73 x Mo17, Illinois Foundation Seeds, Champaign Illinois, U.S.A.) normalized root tissue at the V6 development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing

Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the green house in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected when the maize plant is at the 6-leaf development stage. The root system is cut from the mature maize plant and washed with water to free it from the soil. The tissue is immediately frozen in liquid nitrogen and the harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the normalized cDNA library is constructed as described in Example 2.

The SATMONN06 cDNA library is generated from maize (B73 x Mo17, Illinois Foundation Seeds, Champaign Illinois, U.S.A.) normalized total leaf tissue at the V6 plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental

lighting is provided by 1000 W sodium vapor lamps. Tissue is collected when the maize plant is at the 6-leaf development stage. The older more juvenile leaves, which are in a basal position, as well as the younger more adult leaves, which are more apical are cut at the base of the leaves.

The leaves are then pooled and immediately transferred to liquid nitrogen containers in which the

pooled leaves are crushed. The harvested tissue is then stored at -80°C until RNA preparation.

The RNA is purified from the stored tissue and the normalized cDNA library is constructed as described in Example 2.

The CMZ029 (SATMON036) cDNA library is generated from maize (DK604, Dekalb Genetics, Dekalb, Illinois U.S.A.) endosperm 22 days after pollination. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium.

After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after

transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the green house in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor

lamps. After the V10 stage, the ear shoots of the maize plant, which are ready for fertilization, are enclosed in a paper bag before silk emergent to withhold the pollen. The ear shoots are

pollinated and 22 days after pollination, the ears are pulled out and then the kernels are plucked out of the ears. Each kernel is then dissected into the embryo and the endosperm and the alurone layer is removed. After dissection, the endosperms are immediately frozen in liquid nitrogen and

then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The CMz030 (Lib143) cDNA library is generated from maize seedling tissue two days post germination. Seeds are planted on a moist filter paper on a covered try that is keep in the dark until germination. The trays are then moved to the bench top at 15 hr daytime/9 hr nighttime cycles for 2 days post-germination. The day time temperature is 80°F and the nighttime temperature is 70°F. Tissue is collected when the seedlings are 2 days old. At this stage, the colehrhiza has pushed through the seed coat and the primary root (the radicle) is just piercing the colehrhiza and is barely visible. The seedlings are placed at 42°C for 1 hour.

Following the heat shock treatment, the seedlings are immersed in liquid nitrogen and crushed. The harvested tissue is stored at -80° until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The CMz031 (Lib148) cDNA library is generated from maize pollen tissue at the V10+ plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected from

V10+ stage plants. The ear shoots, which are ready for fertilization, are enclosed in a paper bag to withhold pollen. Twenty-one days after pollination, prior to removing the ears, the paper bag is shaken to collect the mature pollen. The mature pollen is immediately frozen in liquid nitrogen containers and the pollen is crushed. The harvested tissue is then stored at -80°C until

5 RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The CMz033 (Lib189) cDNA library is generated from maize pooled leaf tissue. Samples are harvested from open pollinated plants. Tissue is collected from maize leaves at the anthesis stage. The leaves are collect from from 10-12 plants and frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The CMz034 (Lib3060) cDNA library is generated from maize mature tissue at 40 days post pollination plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime

20 temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected from leaves located two leaves below the ear leaf. This sample represents those genes expressed

during onset and early stages of leaf senescence. The leaves are pooled and immediately transferred to liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

5 The CMz035 (Lib3061) cDNA library is generated from maize endosperm tissue at the V10+ plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected from V10+ stage plants. The ear shoots, which are ready for fertilization, are enclosed in a paper bag prior to silk emergence to withhold pollen. Thirty-two days after pollination, the ears are pulled out and the kernels are removed from the cob. Each kernel is dissected into the embryo and the endosperm and the aleurone layer is removed. After dissection, the endosperms are immediately transferred to liquid nitrogen. The harvested tissue is then stored at 80°C until RNA preparation.

20 The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The CMz036 (Lib3062) cDNA library is generated from maize husk tissue at the 8 week old plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before
5 transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected from 8
10 week old plants. The husk is separated from the ear and immediately transferred to liquid nitrogen containers. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The CMz037 (Lib3059) cDNA library is generated from maize pooled kernal at 12-15
15 days after pollination plant development stage. Sample were collected from field grown material. Whole kernals from hand pollinated (control pollination) are harvested as whole ears and immediately frozen on dry ice. Kernels from 10-12 ears were pooled and ground together in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is
20 purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The CMz039 (Lib3066) cDNA library is generated from maize immature anther tissue at the 7 week old immature tassel stage. Seeds are planted at a depth of approximately 3 cm into 2-

3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected when the maize plant is at the 7 week old immature tassel stage. At this stage, prior to anthesis, the immature anthers are green and enclosed in the staminate spikelet. The developing anthers are dissected away from the 7 week old immature tassel and immediately frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The CMz040 (Lib3067) cDNA library is generated from maize kernel tissue at the V10+ plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F.

Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected from V10+ stage plants. The ear shoots, which are ready for fertilization, are enclosed in a paper bag before silk emergence to withhold pollen. Five to eight days after controlled pollination. The ears are pulled and the kernels removed. The kernels are immediately frozen in liquid nitrogen.

- 5 This sample represents genes expressed in early kernel development, during periods of cell division, amyloplast biogenesis and early carbon flow across the material to filial tissue. The harvested kernels tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The CMz041 (Lib3068) cDNA library is generated from maize pollen germinating silk tissue at the V10+ plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F.

- Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected from V10+ stage plants when the ear shoots are ready for fertilization at the silk emergence stage. The emerging silks are pollinated with an excess of pollen under controlled pollination conditions in the green house. Eighteen hours after pollination the silks are removed from the ears and immediately frozen in liquid nitrogen. This sample represents genes expressed in both pollen
- 20

and silk tissue early in pollination. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The CMz042 (Lib3069) cDNA library is generated from maize ear tissue excessively
5 pollinated at the V10+ plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected from V10+ stage plants and the ear shoots which are ready for fertilization are at the silk emergence stage. The immature ears are pollinated with an excess of pollen under controlled pollination conditions. Eighteen hours post-pollination, the ears are removed and immediately transferred to liquid nitrogen containers. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

20 The CMz044 (Lib3075) cDNA library is generated from maize microspore tissue at the V10+ plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted

into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected from immature anthers from 7 week old tassels. The immature anthers are first dissected from the 7 week old tassel with a scalpel on a glass slide covered with water. The microspores (immature pollen) are released into the water and are recovered by centrifugation. The microspore suspension is immediately frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The CMz045 (Lib3076) cDNA library is generated from maize immature ear megaspore tissue. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental

lighting is provided by 1000 W sodium vapor lamps. Tissue is collected from immature ear (megaspore) obtained from 7 week old plants. The immature ears are harvested from the 7 week old plants and are approximately 2.5 to 3 cm in length. The kernels are removed from the cob immediately frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The CMz047 (Lib3078) cDNA library is generated from maize CO₂ treated high-exposure shoot tissue at the V10+ plant development stage. RX601 maize seeds are sterilized for 1 minute with a 10% clorox solution. The seeds are rolled in germination paper, and germinated in 0.5 mM calcium sulfate solution for two days at 30°C. The seedlings are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium at a rate of 2-3 seedlings per pot. Twenty pots are placed into a high CO₂ environment (approximately 1000 ppm CO₂). Twenty plants were grown under ambient greenhouse CO₂ (approximately 450 ppm CO₂). Plants are watered daily before transplantation and three times a week after transplantation. Peters 20-20-20 fertilizer is also lightly applied. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. At ten days post planting, the shoots from both atmospheres are frozen in liquid nitrogen and lightly ground. The roots are washed in deionized water to remove the support media and the tissue is immediately transferred to liquid nitrogen containers. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The CMz048 (Lib3079) cDNA library is generated from maize basal endosperm transfer layer tissue at the V10+ plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F. Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected from V10+ maize plants. The ear shoots, which are ready for fertilization, are enclosed in a paper bag prior to silk emergence, to withhold the pollen. Kernels are harvested at 12 days post-pollination and placed on wet ice for dissection. The kernels are cross sectioned laterally, dissecting just above the pedicel region, including 1-2 mm of the lower endosperm and the basal endosperm transfer region. The pedicel and lower endosperm region containing the basal endosperm transfer layer is pooled and immediately frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The CMz049(Lib3088) cDNA library is generated from maize immature anther tissue at the 7 week old immature tassel stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily

before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F.

Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected when the maize plant is at the 7 week old immature tassel stage. At this stage, prior to anthesis, the immature anthers are green and enclosed in the staminate spikelet. The developing anthers are dissected away from the 7 week old immature tassel and immediately transferred to liquid nitrogen container. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The CMz050 (Lib3114) cDNA library is generated from maize silk tissue at the V10+ plant development stage. Seeds are planted at a depth of approximately 3 cm into 2-3 inch peat pots containing Metro 200 growing medium. After 2-3 weeks growth they are transplanted into 10 inch pots containing the same growing medium. Plants are watered daily before transplantation and three times a week after transplantation. Peters 15-16-17 fertilizer is applied three times per week after transplanting at a strength of 150 ppm N. Two to three times during the lifetime of the plant, from transplanting to flowering, a total of 900 mg Fe is added to each pot. Maize plants are grown in the greenhouse in 15 hr day/9 hr night cycles. The daytime temperature is approximately 80°F and the nighttime temperature is approximately 70°F.

Supplemental lighting is provided by 1000 W sodium vapor lamps. Tissue is collected when the

maize plant is beyond the 10-leaf development stage and the ear shoots are approximately 15-20 cm in length. The ears are pulled and silks are separated from the ears and immediately transferred to liquid nitrogen containers. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON001 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) total leaf tissue at the V4 plant development stage. Leaf tissue from 38, field grown V4 stage plants is harvested from the 4th node. Leaf tissue is removed from the plants and immediately frozen in dry-ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON002 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) root tissue at the V4 plant development stage. Root tissue from 76, field grown V4 stage plants is harvested. The root systems is cut from the soybean plant and washed with water to free it from the soil and immediately frozen in dry-ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON003 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) seedling hypocotyl axis tissue harvested 2 day post-imbibition. Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium. Trays are placed in an environmental chamber and grown at 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 29°C and the

nighttime temperature approximately 24°C. Soil is checked and watered daily to maintain even moisture conditions. Tissue is collected 2 days after the start of imbibition. The 2 days after imbibition samples are separated into 3 collections after removal of any adhering seed coat. At the 2 day stage, the hypocotyl axis is emerging from the soil. A few seedlings have cracked the soil surface and exhibited slight greening of the exposed cotyledons. The seedlings are washed in water to remove soil, hypocotyl axis harvested and immediately frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON004 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) seedling cotyledon tissue harvested 2 day post-imbibition. Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium. Trays are placed in an environmental chamber and grown at 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 29°C and the nighttime temperature approximately 24°C. Soil is checked and watered daily to maintain even moisture conditions. Tissue is collected 2 days after the start of imbibition. The 2 days after imbibition samples are separated into 3 collections after removal of any adhering seed coat. At the 2 day stage, the hypocotyl axis is emerging from the soil. A few seedlings have cracked the soil surface and exhibited slight greening of the exposed cotyledons. The seedlings are washed in water to remove soil, hypocotyl axis harvested and immediately frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON005 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) seedling hypocotyl axis tissue harvested 6

hour post-imbibition. Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium. Trays are placed in an environmental chamber and grown at 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 29°C and the nighttime temperature approximately 24°C. Soil is checked and watered daily to maintain even moisture conditions. Tissue is collected 6 hours after the start of imbibition. The 6 hours after imbibition samples are separated into 3 collections after removal of any adhering seed coat. The 6 hours after imbibition sample is collected over the course of approximately 2 hours starting at 6 hours post imbibition. At the 6 hours after imbibition stage, not all cotyledons have become fully hydrated and germination, or radicle protrusion, has not occurred. The seedlings are washed in water to remove soil, hypocotyl axis harvested and immediately frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON006 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) seedling cotyledons tissue harvest 6 hour post-imbibition. Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium. Trays are placed in an environmental chamber and grown at 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 29°C and the nighttime temperature approximately 24°C. Soil is checked and watered daily to maintain even moisture conditions. Tissue is collected 6 hours after imbibition. The 6 hours after imbibition samples are separated into 3 collections after removal of any adhering seed coat. The 6 hours after imbibition sample is collected over the course of approximately 2 hours starting at 6 hours post-imbibition. At the 6 hours after imbibition, not all cotyledons have become fully hydrated and germination or radicle protrusion, have not occurred. The seedlings are washed in water to

remove soil, cotyledon harvested and immediately frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON007 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) seed tissue harvested 25 and 35 days post-flowering. Seed pods from field grown plants are harvested 25 and 35 days after flowering and the seeds extracted from the pods. Approximately 4.4g and 19.3g of seeds are harvested from the respective seed pods and immediately frozen in dry ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON008 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) leaf tissue harvested from 25 and 35 days post-flowering plants. Total leaf tissue is harvested from field grown plants. Approximately 19g and 29g of leaves are harvested from the fourth node of the plant 25 and 35 days post-flowering and immediately frozen in dry ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON009 cDNA library is generated from soybean cutlivar C1944 (USDA Soybean Germplasm Collection, Urbana, Illinois U.S.A.) pod and seed tissue harvested 15 days post-flowering. Pods from field grown plants are harvested 15 days post-flowering. Approximately 3g of pod tissue is harvested and immediately frozen in dry-ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON010 cDNA library is generated from soybean cultivar C1944 (USDA Soybean Germplasm Collection, Urbana, Illinois U.S.A.) seed tissue harvested 40 days post-flowering. Pods from field grown plants are harvested 40 days post-flowering. Pods and seeds are separated, approximately 19g of seed tissue is harvested and immediately frozen in dry-ice.

- 5 The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON011 cDNA library is generated from soybean cultivars Cristalina (USDA Soybean Germplasm Collection, Urbana, Illinois U.S.A.) and FT108 (Monsoy, Brazil) (tropical germ plasma) leaf tissue. Leaves are harvested from plants grown in an environmental chamber under 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 29°C and the nighttime temperature approximately 24°C. Soil is checked and watered daily to maintain even moisture conditions. Approximately 30g of leaves are harvested from the 4th node of each of the Cristalina and FT108 cultivars and immediately frozen in dry ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

- 15 The SOYMON012 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) leaf tissue. Leaves from field grown plants are harvested from the fourth node 15 days post-flowering. Approximately 12g of leaves are harvested and immediately frozen in dry ice. The harvested tissue is then stored at -80°C until
- 20 RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON013 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) root and nodule tissue. Approximately, 28g

of root tissue from field grown plants is harvested 15 days post-flowering. The root system is cut from the soybean plant, washed with water to free it from the soil and immediately frozen in dry-ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

5 The SOYMON014 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) seed tissue harvested 25 and 35 days after flowering. Seed pods from field grown plants are harvested 15 days after flowering and the seeds extracted from the pods. Approximately 5g of seeds are harvested from the respective seed pods and immediately frozen in dry ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

10 The SOYMON015 cDNA is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) seed tissue harvested 45 and 55 days post-flowering. Seed pods from field grown plants are harvested 45 and 55 days after flowering and the seeds extracted from the pods. Approximately 19g and 31g of seeds are harvested from the respective seed pods and immediately frozen in dry ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

15 The SOYMON016 cDNA library is generated from soybean cultivar Asgrow 3244
20 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) root tissue. Approximately, 61g and 38g of root tissue from field grown plants is harvested 25 and 35 days post- flowering is harvested. The root system is cut from the soybean plant and washed with water to free it from the soil. The tissue is placed in 14ml polystyrene tubes and immediately frozen in dry-ice. The harvested

tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON017 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) root tissue. Approximately 28g of root tissue from field grown plants is harvested 45 and 55 days post-flowering. The root system is cut from the soybean plant, washed with water to free it from the soil and immediately frozen in dry-ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON018 cDNA is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) leaf tissue harvested 45 and 55 days post-flowering. Leaves from field grown plants are harvested 45 and 55 days after flowering from the fourth node. Approximately 27g and 33g of seeds are harvested from the respective seed pods and immediately frozen in dry ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON019 cDNA library is generated from soybean cultivars Cristalina (USDA Soybean Germplasm Collection, Urbana, Illinois U.S.A.) and FT108 (Monsoy, Brazil) (tropical germ plasma) root tissue. Roots are harvested from plants grown in an environmental chamber under 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 29°C and the nighttime temperature approximately 24°C. Soil is checked and watered daily to maintain even moisture conditions. Approximately 50g and 56g of roots are harvested from each of the Cristalina and FT108 cultivars and immediately frozen in dry ice. The harvested tissue is then

stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON020 cDNA is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) seed tissue harvested 65 and 75 days post-flowering.

5 Seed pods from field grown plants are harvested 45 and 55 days after flowering and the seeds extracted from the pods. Approximately 14g and 31g of seeds are harvested from the respective seed pods and immediately frozen in dry ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

10 The SOYMON021 cDNA library is generated from Soybean Cyst Nematode-resistant soybean cultivar Hartwig (USDA Soybean Germplasm Collection, Urbana, Illinois U.S.A.) root tissue. Plants are grown in tissue culture at room temperature. At approximately 6 weeks post-germination, the plants are exposed to sterilized Soybean Cyst Nematode eggs. Infection is then allowed to progress for 10 days. After the 10 day infection process, the tissue is harvested. Agar from the culture medium and nematodes are removed and the root tissue is immediately frozen in dry ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON022 (Lib3030) cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) partially opened flower tissue.

20 Partially to fully opened flower tissue is harvested from plants grown in an environmental chamber under 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 29°C and the nighttime temperature approximately 24°C. Soil is checked and watered daily to maintain even moisture conditions. A total of 3g of flower tissue is harvested and immediately

frozen in dry ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON023 cDNA library is generated from soybean genotype BW211S Null (Tohoku University, Morioka, Japan) seed tissue harvested 15 and 40 days post-flowering. Seed pods from field grown plants are harvested 15 and 40 days post-flowering and the seeds extracted from the pods. Approximately 0.7g and 14.2g of seeds are harvested from the respective seed pods and immediately frozen in dry ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON024 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) internode-2 tissue harvested 18 days post-imbibition. Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium. The plants are grown in a greenhouse for 18 days after the start of imbibition at ambient temperature. Soil is checked and watered daily to maintain even moisture conditions. Stem tissue is harvested 18 days after the start of imbibition. The samples are divided into hypocotyl and internodes 1 through 5. The fifth internode contains some leaf bud material. Approximately 3 g of each sample is harvested and immediately frozen in dry ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON025 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) leaf tissue harvested 65 days post-flowering. Leaves are harvested from the fourth node of field grown plants 65 days post-flowering. Approximately 18.4g of leaf tissue is harvested and immediately frozen in dry ice. The

harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

SOYMON026 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) root tissue harvested 65 and 75 days post-flowering.

5 Approximately 27g and 40g of root tissue from field grown plants is harvested 65 and 75 days post-flowering. The root system is cut from the soybean plant, washed with water to free it from the soil and immediately frozen in dry-ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

10 The SOYMON027 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) seed tissue harvested 25 days post-flowering. Seed pods from field grown plants are harvested 25 days post-flowering and the seeds extracted from the pods. Approximately 17g of seeds are harvested from the seed pods and immediately frozen in dry ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

15 The SOYMON028 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) drought-stressed root tissue. The plants are grown in an environmental chamber under 12hr daytime/12hr nighttime cycles. The daytime
20 temperature is approximately 29°C and the nighttime temperature 24°C. Soil is checked and watered daily to maintain even moisture conditions. At the R3 stage of development, water is withheld from half of the plant collection (drought stressed population). After 3 days, half of the plants from the drought stressed condition and half of the plants from the control population are

harvested. After another 3 days (6 days post drought induction) the remaining plants are harvested. A total of 27g and 40g of root tissue is harvested and immediately frozen in dry ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

5 The SOYMON029 cDNA library is generated from Soybean Cyst Nematode-resistant soybean cultivar PI07354 (USDA Soybean Germplasm Collection, Urbana, Illinois U.S.A.) root tissue. Late fall to early winter greenhouse grown plants are exposed to Soybean Cyst Nematode eggs. At 10 days post-infection, the plants are uprooted, rinsed briefly and the roots frozen in liquid nitrogen. Approximately 20 grams of root tissue is harvested from the infected plants. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

10 The SOYMON030 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) flower bud tissue. Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium and the plants are grown in an environmental chamber under 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 29°C and the nighttime temperature approximately 24°C. Soil is checked and watered daily to maintain even moisture conditions. Flower buds are removed from the plant at the pedicel. A total of 100mg of flower buds are harvested and immediately frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA
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20 preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

 The SOYMON031 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) carpel and stamen tissue. Seeds are planted

at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium and the plants are grown in an environmental chamber under 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 29°C and the nighttime temperature approximately 24°C. Soil is checked and watered daily to maintain even moisture conditions. Flower buds are removed from the plant at the pedicel. Flowers are dissected to separate petals, sepals and reproductive structures (carpels and stamens). A total of 300mg of carpel and stamen tissue are harvested and immediately frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON032 cDNA library is prepared from the Asgrow cultivar A4922 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) rehydrated dry soybean seed meristem tissue. Surface sterilized seeds are germinated in liquid media for 24 hours. The seed axis is then excised from the barely germinating seed, placed on tissue culture media and incubated overnight at 20°C in the dark. The supportive tissue is removed from the explant prior to harvest. Approximately 570mg of tissue is harvested and frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON033 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) heat-shocked seedling tissue without cotyledons. Seeds are imbibed and germinated in vermiculite for 2 days under constant illumination. After 48 hours, the seedlings are transferred to an incubator set at 40°C under constant illumination. After 30, 60 and 180 minutes seedlings are harvested and dissected. A portion of the seedling consisting of the root, hypocotyl and apical hook is frozen in liquid

nitrogen and stored at -80°C . The seedlings after 2 days of imbibition are beginning to emerge from the vermiculite surface. The apical hooks are dark green in appearance. Total RNA and poly A⁺ RNA is prepared from equal amounts of pooled tissue. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

5 The SOYMON034 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) cold-shocked seedling tissue without cotyledons. Seeds are imbibed and germinated in vermiculite for 2 days under constant illumination. After 48 hours, the seedlings are transferred to a cold room set at 5°C under constant illumination. After 30, 60 and 180 minutes seedlings are harvested and dissected. The seedlings after 2 days of imbibition are beginning to emerge from the vermiculite surface. The apical hooks are dark green in appearance. A portion of the seedling consisting of the root, hypocotyl and apical hook is frozen in liquid nitrogen and stored at -80°C . The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

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20 The SOYMON035 cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) seed coat tissue. Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium and the plants are grown in an environmental chamber under 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 29°C and the nighttime temperature 24°C . Soil is checked and watered daily to maintain even moisture conditions. Seeds are harvested from mid to nearly full maturation (seed coats are not yellowing). The entire embryo proper is removed from the seed coat sample and the seed coat tissue are harvested and immediately frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON036 cDNA library is generated from soybean cultivars PI171451, PI227687 and PI229358 (USDA Soybean Germplasm Collection, Urbana, Illinois U.S.A.) insect challenged leaves. Plants from each of the three cultivars are grown in screenhouse conditions. The screenhouse is divided in half and one half of the screenhouse is infested with soybean
5 looper and the other half infested with velvetbean caterpillar. A single leaf is taken from each of the representative plants at 3 different time points, 11 days after infestation, 2 weeks after infestation and 5 weeks after infestation and immediately frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. Total RNA and poly A+ RNA is isolated from pooled tissue consisting of equal quantities of all 18 samples (3 genotypes X 3 sample times X 2 insect genotypes). The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON037 cDNA library is generated from soybean cultivar A3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) etiolated axis and radical tissue. Seeds are planted in moist vermiculite, wrapped and kept at room temperature in complete darkness until harvest. Etiolated axis and hypocotyl tissue is harvested at 2, 3 and 4 days post-planting. A total of 1 gram of each tissue type is harvested at 2, 3 and 4 days after planting and immediately frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The SOYMON038 cDNA library is generated from soybean variety Asgrow A3237
20 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) rehydrated dry seeds. Explants are prepared for transformation after germination of surface-sterilized seeds on solid tissue media. After 6days, at 28°C and 18 hours of light per day, the germinated seeds are cold shocked at 4°C for 24 hours. Meristemic tissue and part of the hypocotyl is remove and cotyledon excised. The

prepared explant is then wounded for *Agrobacterium* infection. The 2 grams of harvested tissue is frozen in liquid nitrogen and stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

The Soy51 (LIB3027) normalized seed pool cDNA library is prepared from equal amounts tissue harvested from SOYMON007, SOYMON015 and SOYMON020 prepared tissue. Single stranded and double stranded DNA representing approximately 1×10^6 colony forming units are isolated using standard protocols. RNA, complementary to the single stranded DNA, is synthesized using the double stranded DNA as a template. Biotinylated dATP is incorporated into the RNA during the synthesis reaction. The single stranded DNA is mixed with the biotinylated RNA in a 1:10 molar ratio and allowed to hybridize. DNA-RNA hybrids are captured on Dynabeads M280 streptavidin (Dynabeads, Dynal Corporation, Lake Success, New York U.S.A.). The dynabeads with captured hybrids are collected with a magnet. The non-hybridized single stranded molecules remaining after hybrid capture are converted to double stranded form and represent the primary normalized library.

The Soy52 (LIB3028) cDNA library is generated from normalized flower DNA. Single stranded DNA representing approximately 1×10^6 colony forming units of SOYMON022 harvested tissue is used as the starting material for normalization. RNA, complementary to the single stranded DNA, is synthesized using the double stranded DNA as a template. Biotinylated dATP is incorporated into the RNA during the synthesis reaction. The single stranded DNA is mixed with the biotinylated RNA in a 1:10 molar ratio and allowed to hybridize. DNA-RNA hybrids are captured on Dynabeads M280 streptavidin (Dynabeads, Dynal Corporation, Lake Success, New York U.S.A.). The dynabeads with captured hybrids are collected with a magnet.

The non-hybridized single stranded molecules remaining after hybrid capture are converted to double stranded form and represent the primary normalized library.

The Soy53 (LIB3039) cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) seedling shoot apical meristem tissue.

- 5 Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium and the plants are grown in an environmental chamber under 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 29°C and the nighttime temperature 24°C. Soil is checked and watered daily to maintain even moisture conditions. Apical tissue is harvested from seedling shoot meristem tissue, 7-8 days after the start of imbibition. The apex of each seedling is dissected to include the fifth node to the apical meristem. The fifth node corresponds to the third trifoliate leaf in the very early stages of development. Stipules completely envelop the leaf primordia at this time. A total of 200mg of apical tissue is harvested and immediately frozen in liquid nitrogen. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

- 15 The Soy54 (LIB3040) cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) heart to torpedo stage embryo tissue. Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium and the plants are grown in an environmental chamber under 12hr daytime/12hr
- 20 nighttime cycles. The daytime temperature is approximately 29°C and the nighttime temperature 24°C. Soil is checked and watered daily to maintain even moisture conditions. Seeds are collected and embryos removed from surrounding endosperm and maternal tissues. Embryos from globular to young torpedo stages (by corresponding analogy to *Arabidopsis*) are collected

with a bias towards the middle of this spectrum. Embryos which are beginning to show asymmetric development of cotyledons are considered the upper developmental boundary for the collection and are excluded. A total of 12 mg embryo tissue is frozen in liquid nitrogen. The harvested tissue is stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

Soy55 (LIB3049) cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) young seed tissue. Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium and the plants are grown in an environmental chamber under 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 29°C and the nighttime temperature 24°C. Soil is checked and watered daily to maintain even moisture conditions. Seeds are collected from very young pods (5 to 15 days after flowering). A total of 100mg of seeds are harvested and frozen in liquid nitrogen. The harvested tissue is stored at -80°C until RNA preparation. The RNA is purified from the stored tissue and the cDNA library is constructed as described in Example 2.

Soy56 (LIB3029) non-normalized seed pool cDNA library is prepared from equal amounts tissue harvested from SOYMON007, SOYMON015 and SOYMON020 prepared tissue. Single stranded and double stranded DNA representing approximately 1×10^6 colony forming units are isolated using standard protocols. RNA, complementary to the single stranded DNA, is synthesized using the double stranded DNA as a template. Biotinylated dATP is incorporated into the RNA during the synthesis reaction. The single stranded DNA is mixed with the biotinylated RNA in a 1:10 molar ratio and allowed to hybridize. DNA-RNA hybrids are captured on Dynabeads M280 streptavidin (Dynabeads, Dynal Corporation, Lake Success, New York U.S.A.). The dynabeads with captured hybrids are collected with a magnet. The non-

hybridized single stranded molecules remaining after hybrid capture are not converted to double stranded form and represent a non-normalized seed pool for comparison to Soy51 cDNA libraries.

TheSoy58 (LIB3050) cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) drought stressed root tissue subtracted from control root tissue. Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium and the plants are grown in an environmental chamber under 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 29°C and the nighttime temperature 24°C. Soil is checked and watered daily to maintain even moisture conditions. At the R3 stage of the plant drought is induced by withholding water. After 3 and 6 days root tissue from both drought stressed and control (watered regularly) plants are collected and frozen in dry-ice. The harvested tissue is stored at -80°C until RNA preparation. The RNA is prepared from the stored tissue and the subtracted cDNA library is constructed as described in Example 2.

The Soy59 (LIB3051) cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) endosperm tissue. Seeds are germinated on paper towels under laboratory ambient light conditions. At 8, 10 and 14 hours after imbibition, the seed coats are harvested. The endosperm consists of a very thin layer of tissue affixed to the inside of the seed coat. The seed coat and endosperm are frozen immediately after harvest in liquid nitrogen. The harvested tissue is stored at -80°C until RNA preparation. The RNA is prepared from the stored tissue and the cDNA library is constructed as described in Example 2.

The Soy60 (LIB3072) cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) drought stressed seed plus pod subtracted

from control seed plus pod tissue. Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium and the plants are grown in an environmental chamber under 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 26°C and the nighttime temperature 21°C and 70% relative humidity. Soil is checked and
5 watered daily to maintain even moisture conditions. At the R3 stage of the plant drought is induced by withholding water. After 3 and 6 days seeds and pods from both drought stressed and control (watered regularly) plants are collected from the fifth and sixth node and frozen in dry-ice. The harvested tissue is stored at -80°C until RNA preparation. The RNA is prepared from the stored tissue and the subtracted cDNA library is constructed as described in Example 2.

The Soy61 (LIB3073) cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) jasmonic acid treated seedling subtracted from control tissue. Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium and the plants are grown in a greenhouse. The daytime temperature is approximately 29.4°C and the nighttime temperature 20°C. Soil is checked and watered daily to maintain even moisture conditions. At 9 days post planting, the plantlets are sprayed with either control buffer of 0.1% Tween-20 or jasmonic acid (Sigma J-2500, Sigma, St. Louis, Missouri U.S.A.) at 1 mg/ml in 0.1% Tween-20. Plants are sprayed until runoff and the soil and the stem is soaked with the spraying solution. At 18 hours post application of jasmonic acid, the soybean plantlets appear growth retarded. After 18 hours, 24 hours and 48 hours post
20 treatment, the cotyledons are removed and the remaining leaf and stem tissue above the soil is harvested and frozen in liquid nitrogen. The harvested tissue is stored at -80°C until RNA preparation. To make RNA, the three sample timepoints were combined and ground. The RNA is prepared from the stored tissue and the subtracted cDNA library is constructed as described in

Example 2. For this library's construction, the eighth fraction of the cDNA size fractionation step was used for ligation.

The Soy62 (LIB3074) cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) jasmonic acid treated seedling subtracted from control tissue. Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium and the plants are grown in a greenhouse. The daytime temperature is approximately 29.4°C and the nighttime temperature 20°C. Soil is checked and watered daily to maintain even moisture conditions. At 9 days post planting, the plantlets are sprayed with either control buffer of 0.1% Tween-20 or jasmonic acid (Sigma J-2500, Sigma, St. Louis, Missouri U.S.A.) at 1 mg/ml in 0.1% Tween-20. Plants are sprayed until runoff and the soil and the stem is soaked with the spraying solution. At 18 hours post application of jasmonic acid, the soybean plantlets appear growth retarded. After 18 hours, 24 hours and 48 hours post treatment, the cotyledons are removed and the remaining leaf and stem tissue above the soil is harvested and frozen in liquid nitrogen. The harvested tissue is stored at -80°C until RNA preparation. To make RNA, the three sample timepoints were combined and ground. The RNA is prepared from the stored tissue and the subtracted cDNA library is constructed as described in Example 2. For this library's construction, the ninth fraction of the cDNA size fractionation step was used for ligation.

The Soy65 (LIB3107) cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) drought-stressed abscission zone tissue. Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium and the plants are grown in an environmental chamber under 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 29°C and the nighttime temperature

24°C. Soil is checked and watered daily to maintain even moisture conditions. Plants are irrigated with 15-16-17 Peter's Mix. At the R3 stage of development, drought is imposed by withholding water. At 3, 4, 5 and 6 days, tissue is harvested and wilting is not obvious until the fourth day. Abscission layers from reproductive organs are harvested by cutting less than one millimeter proximal and distal to the layer and immediately frozen in liquid nitrogen. The harvested tissue is stored at -80°C until RNA preparation. The RNA is prepared from the stored tissue and the cDNA library is constructed as described in Example 2.

The Soy66 (LIB3109) cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) non-drought stressed abscission zone tissue. Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium and the plants are grown in an environmental chamber under 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 29°C and the nighttime temperature approximately 24°C. Soil is checked and watered daily to maintain even moisture conditions. Plants are irrigated with 15-16-17 Peter's Mix. At 3, 4, 5 and 6 days, control abscission layer tissue is harvested. Abscission layers from reproductive organs are harvested by cutting less than one millimeter proximal and distal to the layer and immediately frozen in liquid nitrogen. The harvested tissue is stored at -80°C until RNA preparation. The RNA is prepared from the stored tissue and the cDNA library is constructed as described in Example 2.

Soy67 (LIB3065) normalized seed pool cDNA library is prepared from equal amounts tissue harvested from SOYMON007, SOYMON015 and SOYMON020 prepared tissue. Single stranded and double stranded DNA representing approximately 1×10^6 colony forming units are isolated using standard protocols. RNA, complementary to the single stranded DNA, is synthesized using the double stranded DNA as a template. Biotinylated dATP is incorporated

into the RNA during the synthesis reaction. The single stranded DNA is mixed with the biotinylated RNA in a 1:10 molar ratio) and allowed to hybridize. DNA-RNA hybrids are captured on Dynabeads M280 streptavidin (Dynabeads, Dynal Corporation, Lake Success, New York U.S.A.). The dynabeads with captured hybrids are collected with a magnet. Captured hybrids are eluted with water.

Soy68 (LIB3052) normalized seed pool cDNA library is prepared from equal amounts tissue harvested from SOYMON007, SOYMON015 and SOYMON020 prepared tissue. Single stranded and double stranded DNA representing approximately 1×10^6 colony forming units are isolated using standard protocols. RNA, complementary to the single stranded DNA, is synthesized using the double stranded DNA as a template. Biotinylated dATP is incorporated into the RNA during the synthesis reaction. The single stranded DNA is mixed with the biotinylated RNA in a 1:10 molar ratio) and allowed to hybridize. DNA-RNA hybrids are captured on Dynabeads M280 streptavidin (Dynabeads, Dynal Corporation, Lake Success, New York U.S.A.). The dynabeads with captured hybrids are collected with a magnet. Captured hybrids are eluted with water.

Soy69 (LIB3053) normalized cDNA library is generated from soybean cultivars Cristalina (USDA Soybean Germplasm Collection, Urbana, Illinois U.S.A.) and FT108 (Monsoy, Brazil) (tropical germ plasma) normalized leaf tissue. Leaves are harvested from plants grown in an environmental chamber under 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 29°C and the nighttime temperature approximately 24°C. Soil is checked and watered daily to maintain even moisture conditions. Approximately 30g of leaves are harvested from the 4th node of each of the Cristalina and FT108 cultivars and immediately frozen in dry ice. The harvested tissue is then stored at -80°C until RNA

preparation. The RNA is prepared from the stored tissue and the normalized cDNA library is constructed as described in Example 2.

Soy70 (LIB3055) cDNA library is generated from soybean cultivars Cristalina (USDA Soybean Germplasm Collection, Urbana, Illinois U.S.A.) and FT108 (Monsoy, Brazil) (tropical germ plasma) leaf tissue. Leaves are harvested from plants grown in an environmental chamber under 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 29°C and the nighttime temperature approximately 24°C. Soil is checked and watered daily to maintain even moisture conditions. Approximately 30g of leaves are harvested from the 4th node of each of the Cristalina and FT108 cultivars and immediately frozen in dry ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is prepared from the stored tissue and the cDNA library is constructed as described in Example 2.

Soy71 (LIB3056) cDNA library is generated from soybean cultivars Cristalina and FT108 (tropical germ plasma) root tissue. Roots are harvested from plants grown in an environmental chamber under 12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 29°C and the nighttime temperature approximately 24°C. Soil is checked and watered daily to maintain even moisture conditions. Approximately 50g and 56g of roots are harvested from each of the Cristalina and FT108 cultivars and immediately frozen in dry ice. The harvested tissue is then stored at -80°C until RNA preparation. The RNA is prepared from the stored tissue and the cDNA library is constructed as described in Example 2.

Soy73 (LIB3093) cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) drought stressed leaf subtracted from control tissue. Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium and the plants are grown in an environmental chamber under

12hr daytime/12hr nighttime cycles. The daytime temperature is approximately 26°C and the nighttime temperature 21°C and 70% relative humidity. Soil is checked and watered daily to maintain even moisture conditions. At the R3 stage of the plant drought is induced by withholding water. After 3 and 6 days seeds and pods from both drought stressed and control (watered regularly) plants are collected from the fifth and sixth node and frozen in dry-ice. The harvested tissue is stored at -80°C until RNA preparation. The RNA is prepared from the stored tissue and the subtraction cDNA library is constructed as described in Example 2.

The Soy76 (Lib3106) cDNA library is generated from soybean cultivar Asgrow 3244 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) jasmonic acid and arachidonic treated seedling subtracted from control tissue. Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium and the plants are grown in a greenhouse. The daytime temperature is approximately 29.4°C and the nighttime temperature 20°C. Soil is checked and watered daily to maintain even moisture conditions. At 9 days post planting, the plantlets are sprayed with either control buffer of 0.1% Tween-20 or jasmonic acid (Sigma J-2500, Sigma, St. Louis, Missouri U.S.A.) at 1 mg/ml in 0.1% Tween-20. Plants are sprayed until runoff and the soil and the stem is soaked with the spraying solution. At 18 hours post application of jasmonic acid, the soybean plantlets appear growth retarded. Arachidonic treated seedlings are sprayed with 1m/ml arachidonic acid in 0.1% Tween-20. After 18hours, 24hours and 48 hours post treatment, the cotyledons are removed and the remaining leaf and stem tissue above the soil is harvested and frozen in liquid nitrogen. The harvested tissue is stored at -80°C until RNA preparation. To make RNA, the three sample timepoints were combined and ground. The RNA from the arachidonic treated seedlings is isolated separately. The RNA is prepared from the stored tissue and the subtraction cDNA library is constructed as described in Example 2.

For this subtraction library, fraction 10 of the size fractionated cDNA is ligated into the pSPORT vector (Invitrogen, Carlsbad California U.S.A.) in order to capture some of the smaller transcripts characteristic of antifungal proteins.

Soy77 (LIB3108) cDNA library is generated from soybean cultivar Asgrow 3244

5 (Asgrow Seed Company, Des Moines, Iowa U.S.A.) jasmonic acid control tissue. Seeds are planted at a depth of approximately 2cm into 2-3 inch peat pots containing Metromix 350 medium and the plants are grown in a greenhouse. The daytime temperature is approximately 29.4°C and the nighttime temperature 20°C. Soil is checked and watered daily to maintain even moisture conditions. At 9 days post planting, the plantlets are sprayed with either control buffer of 0.1% Tween-20 or jasmonic acid (Sigma J-2500, Sigma, St. Louis, Missouri U.S.A.) at 1 mg/ml in 0.1% Tween-20. Plants are sprayed until runoff and the soil and the stem is soaked with the spraying solution. At 18 hours post application of jasmonic acid, the soybean plantlets appear growth retarded. Arachidonic treated seedlings are sprayed with 1m/ml arachidonic acid in 0.1% Tween-20. After 18 hours, 24 hours and 48 hours post treatment, the cotyledons are removed and the remaining leaf and stem tissue above the soil is harvested and frozen in liquid nitrogen. The harvested tissue is stored at -80°C until RNA preparation. To make RNA, the three sample timepoints were combined and ground. The RNA from the arachidonic treated seedlings is isolated separately. The RNA is prepared from the stored tissue and the subtraction cDNA library is constructed as described in Example 2. For this subtraction cDNA library,
20 fraction 10 of the size fractionated cDNA is ligated into the pSPORT vector in order to capture some of the smaller transcripts characteristic of antifungal proteins.

Example 2

The stored RNA is purified using Trizol reagent from Life Technologies (Gibco BRL, Life Technologies, Gaithersburg, Maryland U.S.A.), essentially as recommended by the manufacturer. Poly A+ RNA (mRNA) is purified using magnetic oligo dT beads essentially as
5 recommended by the manufacturer (Dynabeads, Dynal Corporation, Lake Success, New York U.S.A.).

Construction of plant cDNA libraries is well-known in the art and a number of cloning strategies exist. A number of cDNA library construction kits are commercially available. The Superscript™ Plasmid System for cDNA synthesis and Plasmid Cloning (Gibco BRL, Life
10 Technologies, Gaithersburg, Maryland U.S.A.) is used, following the conditions suggested by the manufacturer.

Normalized libraries are made using essentially the Soares procedure (Soares *et al.*, *Proc. Natl. Acad. Sci. (U.S.A.)* 91:9228-9232 (1994), the entirety of which is herein incorporated by
15 reference). This approach is designed to reduce the initial 10,000-fold variation in individual cDNA frequencies to achieve abundances within one order of magnitude while maintaining the overall sequence complexity of the library. In the normalization process, the prevalence of high-abundance cDNA clones decreases dramatically, clones with mid-level abundance are relatively unaffected and clones for rare transcripts are effectively increased in abundance.

Normalized libraries are prepared from single-stranded and double-stranded DNA.
20 Single-stranded and double-stranded DNA representing approximately 1×10^6 colony forming units are isolated using standard protocols. RNA, complementary to the single-stranded DNA, is synthesized using the double stranded DNA as a template. Biotinylated dATP is incorporated

into the RNA during the synthesis reaction. The single-stranded DNA is mixed with the biotinylated RNA in a 1:10 molar ratio) and allowed to hybridize. DNA-RNA hybrids are captured on Dynabeads M280 streptavidin (Dynabeads, Dynal Corporation, Lake Success, New York U.S.A.). The dynabeads with captured hybrids are collected with a magnet. The non-
5 hybridized single-stranded molecules remaining after hybrid capture are converted to double stranded form and represent the primary normalized library.

For subtraction, target cDNA is made from the drought stressed tissue total RNA using the SMART cDNA synthesis system from Clontech (Clontech Laboratories, Palo Alto, California U.S.A.). Driver first strand cDNA is covalently linked to Dynabeads following a
10 protocol similar to that described in the Dynal literature (Dynabeads, Dynal Corporation, Lake Success, New York U.S.A.). The target cDNA is then heat denatured and the second strand trapped using Dynabeads oligo-dT. The target second strand cDNA is then hybridized to the driver cDNA in 400µl 2X SSPE for two rounds of hybridization at 65°C and 20 hours. After
15 each hybridization, the hybridization solution is removed from the system and the hybridized target cDNA removed from the driver by heat denaturation in water. After hybridization, the remaining cDNA is trapped with Dynabeads oligo-dT. The trapped cDNA is then amplified as in previous PCR based libraries and the resulting cDNA ligated into the pSPORT vector (Invitrogen, Carlsbad California U.S.A.).

Example 3

20 The cDNA libraries are plated on LB agar containing the appropriate antibiotics for selection and incubated at 37° for a sufficient time to allow the growth of individual colonies. Single colonies are individually placed in each well of a 96-well microtiter plates containing LB

liquid including the selective antibiotics. The plates are incubated overnight at approximately 37°C with gentle shaking to promote growth of the cultures. The plasmid DNA is isolated from each clone using Qiaprep plasmid isolation kits, using the conditions recommended by the manufacturer (Qiagen Inc., Santa Clara, California U.S.A.).

5 Template plasmid DNA clones are used for subsequent sequencing. For sequencing, the ABI PRISM dRhodamine Terminator Cycle Sequencing Ready Reaction Kit with AmpliTaq® DNA Polymerase, FS, is used (PE Applied Biosystems, Foster City, California U.S.A.).

Example 4

10 Nucleic acid sequences that encode for the following tocopherol synthesis pathway enzymes: deoxyarabiono-heptulosonate-P-synthase; putative deoxyarabiono-heptulosonate-P-synthase; dehydroquinase synthase; dehydroquinase dehydratase; putative dehydroquinase dehydratase; shikimate dehydrogenase; shikimate kinase; enolpyruvylshikimate-P-synthase; chorismate synthase; chorismate mutase; tyrosine transaminase; putative tyrosine transaminase; transaminase A; putative transaminase A; 4-hydroxyphenylpyruvate dioxygenase; homogentisic acid dioxygenase; and geranylgeranylpyrophosphate synthase are identified from the Monsanto EST PhytoSeq database using TBLASTN (default values)(TBLASTN compares a protein query against the six reading frames of a nucleic acid sequence). Matches found with BLAST P values equal or less than 0.001 (probability) or BLAST Score of equal or greater than 90 are classified as hits. If the program used to determine the hit is HMMSW then the score refers to HMMSW
15
20 score.

In addition, the GenBank database is searched with BLASTN and BLASTX (default values) using ESTs as queries. EST that pass the hit probability threshold of $10e^{-8}$ for the

following enzymes are combined with the hits generated by using TBLASTN (described above) and classified by enzyme (see Table A below).

A cluster refers to a set of overlapping clones in the PhytoSeq database. Such an overlapping relationship among clones is designated as a “cluster” when BLAST scores from pairwise sequence comparisons of the member clones meets a predetermined minimum value or product score of 50 or more (Product Score = (BLAST SCORE x Percentage Identity)/(5 x minimum [length (Seq1), length (Seq2)])).

Since clusters are formed on the basis of single-linkage relationships, it is possible for two non-overlapping clones to be members of the same cluster if, for instance, they both overlap a third clone with at least the predetermined minimum BLAST score (stringency). A cluster ID is arbitrarily assigned to all of those clones which belong to the same cluster at a given stringency and a particular clone will belong to only one cluster at a given stringency. If a cluster contains only a single clone (a “singleton”), then the cluster ID number will be negative, with an absolute value equal to the clone ID number of its single member. Clones grouped in a cluster in most cases represent a contiguous sequence.

TABLE A*

deoxyarabiono-heptulosonate-P-synthase-maize								
Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
1	-700223776	700223776H1	SATMON011	g2398680	BLASTN	388	1e-51	77
2	-700260027	700260027H1	SATMON017	g169475	BLASTX	112	1e-10	75
3	-700356188	700356188H1	SATMON024	g2398679	BLASTX	93	1e-13	78
4	-700430072	700430072H1	SATMONN01	g2398679	BLASTX	180	1e-17	85
5	1228	700623827H1	SATMON034	g416252	BLASTN	1030	1e-105	87
6	1228	700452503H1	SATMON028	g416252	BLASTN	1141	1e-88	87
7	1228	700551557H1	SATMON022	g416252	BLASTN	547	1e-83	88
8	1228	700571345H1	SATMON030	g416252	BLASTN	712	1e-83	83
9	1228	700452527H1	SATMON028	g416252	BLASTN	908	1e-83	88
10	1228	700050505H1	SATMON003	g416252	BLASTN	1080	1e-83	90
11	1228	700551749H1	SATMON022	g416252	BLASTN	1029	1e-79	90
12	1228	700569172H1	SATMON030	g416252	BLASTN	993	1e-76	84
13	1228	700613721H1	SATMON033	g416252	BLASTN	491	1e-75	85
14	1228	700160395H1	SATMON012	g416252	BLASTN	969	1e-74	91
15	1228	701163236H1	SATMONN04	g416252	BLASTN	721	1e-73	84
16	1228	700267876H1	SATMON017	g416252	BLASTN	555	1e-65	86
17	1228	700096649H1	SATMON008	g169474	BLASTN	889	1e-65	79
18	1228	700346229H1	SATMON021	g166687	BLASTN	880	1e-64	78
19	1228	700259208H1	SATMON017	g169474	BLASTN	754	1e-63	76
20	1228	700454345H1	SATMON029	g416252	BLASTN	828	1e-62	86
21	1228	700151789H1	SATMON007	g416252	BLASTN	830	1e-62	87
22	1228	700803047H1	SATMON036	g169474	BLASTN	658	1e-61	77
23	1228	700049005H1	SATMON003	g416252	BLASTN	818	1e-61	89
24	1228	700617057H1	SATMON033	g170224	BLASTN	737	1e-60	79
25	1228	700204532H1	SATMON003	g2398680	BLASTN	486	1e-58	75
26	1228	700195344H1	SATMON014	g416252	BLASTN	774	1e-58	90
27	1228	700041845H1	SATMON004	g170224	BLASTN	806	1e-58	78
28	1228	700452030H1	SATMON028	g416252	BLASTN	574	1e-57	87
29	1228	700093451H1	SATMON008	g169474	BLASTN	511	1e-56	74
30	1228	700048096H1	SATMON003	g169474	BLASTN	774	1e-55	75
31	1228	700424054H1	SATMONN01	g170224	BLASTN	444	1e-54	81
32	1228	700448927H1	SATMON028	g416252	BLASTN	736	1e-54	83
33	1228	700579786H1	SATMON031	g169474	BLASTN	737	1e-52	74
34	1228	700168659H1	SATMON013	g169474	BLASTN	727	1e-51	79
35	1228	700150987H1	SATMON007	g166687	BLASTN	711	1e-50	81
36	1228	700022040H1	SATMON001	g294284	BLASTN	713	1e-50	80
37	1228	700449746H2	SATMON028	g416252	BLASTN	680	1e-49	90
38	1228	700166534H1	SATMON013	g169474	BLASTN	696	1e-49	76
39	1228	700257864H1	SATMON017	g169474	BLASTN	693	1e-48	78
40	1228	700452534H1	SATMON028	g416252	BLASTN	636	1e-45	85
41	1228	700042596H1	SATMON004	g416252	BLASTN	640	1e-45	84
42	1228	700151812H1	SATMON007	g416252	BLASTN	643	1e-45	89
43	1228	700421687H1	SATMONN01	g170224	BLASTN	646	1e-45	76
44	1228	700052344H1	SATMON003	g170224	BLASTN	657	1e-45	80
45	1228	701178585H1	SATMONN05	g166687	BLASTN	427	1e-44	80
46	1228	700239365H1	SATMON010	g170224	BLASTN	628	1e-43	80
47	1228	700153542H1	SATMON007	g169474	BLASTN	617	1e-42	76
48	1228	700380557H1	SATMON021	g416252	BLASTN	500	1e-41	90

49	1228	700570454H1	SATMON030	g170224	BLASTN	614	1e-41	79
50	1228	700264817H1	SATMON017	g169474	BLASTN	410	1e-39	75
51	1228	700153524H1	SATMON007	g169474	BLASTN	361	1e-37	77
52	1228	700618945H1	SATMON034	g416252	BLASTN	458	1e-36	79
53	1228	700193060H1	SATMON014	g1245452	BLASTN	547	1e-36	74
54	1228	700047557H1	SATMON003	g416252	BLASTN	511	1e-34	83
55	1228	700341009H1	SATMON020	g169474	BLASTN	324	1e-30	66
56	1228	700048589H1	SATMON003	g166689	BLASTN	409	1e-30	77
57	1228	700334956H1	SATMON019	g2398681	BLASTX	183	1e-26	85
58	1228	700027629H1	SATMON003	g169475	BLASTX	189	1e-19	87
59	29578	700219020H1	SATMON011	g2398678	BLASTN	694	1e-49	72
60	3007	700153267H1	SATMON007	g2398678	BLASTN	587	1e-40	71
61	3007	700352639H1	SATMON024	g2398678	BLASTN	506	1e-33	70
62	3007	700259481H1	SATMON017	g2398678	BLASTN	268	1e-13	66
63	31415	700219261H1	SATMON011	g166689	BLASTN	501	1e-32	77
64	32242	700090119H1	SATMON011	g2398680	BLASTN	803	1e-58	76
65	3227	700268010H1	SATMON017	g2398680	BLASTN	773	1e-55	73
66	3227	700450763H1	SATMON028	g166689	BLASTN	713	1e-50	73
67	3227	700241730H1	SATMON010	g2398680	BLASTN	686	1e-48	73
68	3227	700071633H1	SATMON007	g166689	BLASTN	628	1e-43	71
69	3227	700267002H1	SATMON017	g169474	BLASTN	446	1e-26	74
70	3227	700452543H1	SATMON028	g2546987	BLASTN	281	1e-25	75
71	5023	700378721H1	SATMON020	g2546988	BLASTX	183	1e-18	94
72	-L1487205	LIB148-064-Q1-E1-F6	LIB148	g2398679	BLASTX	296	1e-53	59
73	-L30622733	LIB3062-014-Q1-K1-D2	LIB3062	g2546987	BLASTN	484	1e-31	68
74	-L30622734	LIB3062-014-Q1-K1-D6	LIB3062	g416252	BLASTN	479	1e-29	68
75	-L30661773	LIB3066-011-Q1-K1-D6	LIB3066	g170224	BLASTN	747	1e-52	70
76	-L30664853	LIB3066-031-Q1-K1-F6	LIB3066	g169474	BLASTN	1139	1e-86	72
77	-L30685059	LIB3068-008-Q1-K1-A11	LIB3068	g166687	BLASTN	450	1e-26	64
78	-L30691358	LIB3069-002-Q1-K1-D6	LIB3069	g2398680	BLASTN	466	1e-28	60
79	1228	LIB3062-032-Q1-K1-F11	LIB3062	g416252	BLASTN	1508	1e-119	88
80	1228	LIB143-004-Q1-E1-H9	LIB143	g169474	BLASTN	1221	1e-92	78
81	1228	LIB3069-027-Q1-K1-E11	LIB3069	g169474	BLASTN	746	1e-91	77
82	1228	LIB143-045-Q1-E1-F10	LIB143	g170224	BLASTN	1056	1e-79	77
83	1228	LIB3069-001-Q1-K1-E2	LIB3069	g416252	BLASTN	598	1e-78	87
84	1228	LIB3068-006-Q1-K1-F10	LIB3068	g169474	BLASTN	1048	1e-78	74
85	1228	LIB3062-008-Q1-K1-A5	LIB3062	g169474	BLASTN	806	1e-75	79
86	1228	LIB148-045-Q1-E1-G7	LIB148	g2398678	BLASTN	735	1e-60	72
87	1228	LIB3068-034-Q1-K1-E6	LIB3068	g170224	BLASTN	819	1e-59	78
88	1228	LIB3061-040-Q1-K1-B8	LIB3061	g170224	BLASTN	771	1e-54	80
89	1228	LIB143-024-Q1-E1-B4	LIB143	g169474	BLASTN	736	1e-50	73
90	1228	LIB3068-032-Q1-K1-D10	LIB3068	g169474	BLASTN	598	1e-39	72
91	24030	LIB3066-047-Q1-K1-A9	LIB3066	g170225	BLASTX	121	1e-30	57
92	29578	LIB3066-011-Q1-K1-D4	LIB3066	g2546987	BLASTN	1212	1e-92	75
93	29578	LIB148-058-Q1-E1-F2	LIB148	g169474	BLASTN	680	1e-47	72
94	31415	LIB148-009-Q1-E1-E8	LIB148	g2398680	BLASTN	492	1e-29	74
95	32242	LIB148-018-Q1-E1-B2	LIB148	g2398680	BLASTN	1280	1e-97	76
96	32242	LIB3067-058-Q1-K1-C8	LIB3067	g2398680	BLASTN	1079	1e-81	76
97	5023	LIB3079-006-Q1-K1-D10	LIB3079	g2398681	BLASTX	143	1e-28	88

putative deoxyarabiono-heptulosonate-P-synthase-maize								
Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
98	-701178041	701178041H1	SATMONN05	g1742787	BLASTX	121	1e-9	49
99	13211	700267210H1	SATMON017	g1742787	BLASTX	72	1e-9	59

deoxyarabiono-heptulosonate-P-synthase-soybean								
Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
100	-700750583	700750583H1	SOYMON014	g169475	BLASTX	149	1e-13	78
101	-700756739	700756739H1	SOYMON014	g410315	BLASTX	170	1e-21	55
102	-700897290	700897290H1	SOYMON027	g1245452	BLASTN	1047	1e-78	93
103	-700953858	700953858H1	SOYMON022	g2398678	BLASTN	673	1e-47	74
104	-700958333	700958333H1	SOYMON022	g2398678	BLASTN	531	1e-35	77
105	-701212422	701212422H1	SOYMON035	g410487	BLASTN	527	1e-35	77
106	11948	701214211H1	SOYMON035	g2398678	BLASTN	860	1e-62	79
107	11948	700941217H1	SOYMON024	g2398678	BLASTN	843	1e-61	79
108	11948	700749762H1	SOYMON013	g2398678	BLASTN	659	1e-58	79
109	11948	701015341H1	SOYMON019	g169474	BLASTN	758	1e-54	78
110	11948	700787714H2	SOYMON011	g169474	BLASTN	613	1e-42	80
111	11948	700963862H1	SOYMON022	g2398678	BLASTN	581	1e-39	78
112	11948	701144405H1	SOYMON031	g2546987	BLASTN	266	1e-27	71
113	11948	700897376H1	SOYMON027	g2398679	BLASTX	136	1e-21	85
114	12144	700564714H1	SOYMON002	g170225	BLASTX	78	1e-14	54
115	12144	701036988H1	SOYMON029	g170225	BLASTX	64	1e-10	55
116	12144	701142430H1	SOYMON038	g170225	BLASTX	66	1e-10	52
117	18499	700746365H1	SOYMON013	g1245452	BLASTN	726	1e-62	85
118	18499	700565543H1	SOYMON002	g1245452	BLASTN	700	1e-49	88
119	19009	700953162H1	SOYMON022	g166689	BLASTN	679	1e-47	74
120	19009	700681944H1	SOYMON008	g2398680	BLASTN	613	1e-42	77
121	19576	701097076H1	SOYMON028	g1245452	BLASTN	1156	1e-87	92
122	19576	700669658H1	SOYMON006	g1245452	BLASTN	895	1e-65	90
123	19576	700656892H1	SOYMON004	g410487	BLASTN	410	1e-48	79
124	5102	700901033H1	SOYMON027	g2398678	BLASTN	894	1e-65	82
125	5102	700901290H1	SOYMON027	g2398678	BLASTN	837	1e-60	82
126	5102	701051386H1	SOYMON032	g170224	BLASTN	819	1e-59	81
127	5102	700755856H1	SOYMON014	g170224	BLASTN	782	1e-56	82
128	5102	701145291H1	SOYMON031	g170224	BLASTN	487	1e-48	80
129	5234	700565904H1	SOYMON002	g2398678	BLASTN	584	1e-77	84
130	5234	701138971H1	SOYMON038	g2398678	BLASTN	946	1e-70	84
131	5234	700725760H1	SOYMON009	g2398678	BLASTN	908	1e-66	82
132	5234	701097139H1	SOYMON028	g2398678	BLASTN	772	1e-55	79
133	5234	700952432H1	SOYMON022	g2398680	BLASTN	689	1e-48	81
134	5234	700996417H1	SOYMON018	g410487	BLASTN	468	1e-40	81
135	5699	701040351H1	SOYMON029	g166690	BLASTX	203	1e-21	69
136	5699	700847113H1	SOYMON021	g2398679	BLASTX	147	1e-13	72
137	5699	700967767H1	SOYMON033	g166690	BLASTX	149	1e-13	63
138	5699	700841638H1	SOYMON020	g166690	BLASTX	141	1e-12	62
139	5699	700891749H1	SOYMON024	g410486	BLASTX	127	1e-10	76
140	5699	700990984H1	SOYMON011	g2398679	BLASTX	127	1e-10	67
141	5699	700740310H1	SOYMON012	g410486	BLASTX	127	1e-10	76
142	5699	700834916H1	SOYMON019	g294285	BLASTX	117	1e-9	77
143	6819	700652910H1	SOYMON003	g1245452	BLASTN	1408	1e-109	89

144	6819	700761928H1	SOYMON015	g1245452	BLASTN	924	1e-68	89
145	6935	700987126H1	SOYMON009	g2398678	BLASTN	667	1e-46	72
146	6935	700734128H1	SOYMON010	g169474	BLASTN	533	1e-35	72

putative deoxyarabiono-heptulosonate-P-synthase -soybean

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
147	-700891658	700891658H1	SOYMON024	g1742787	BLASTX	119	1e-9	40
148	-701148391	701148391H1	SOYMON031	g1742787	BLASTX	109	1e-9	43
149	4075	700992239H1	SOYMON011	g1742787	BLASTX	66	1e-9	40
150	4075	700686128H1	SOYMON008	g1742787	BLASTX	62	1e-8	39
151	19576	LIB3029-012-Q1-B1-B5	LIB3029	g2546987	BLASTN	1280	1e-97	80
152	5699	LIB3052-011-Q1-N1-E8	LIB3052	g166690	BLASTX	187	1e-39	56

dehydroquinase synthase-maize

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
153	-700257536	700257536H1	SATMON017	g309862	BLASTX	102	1e-21	69
154	28069	700203301H1	SATMON003	g1789791	BLASTX	140	1e-16	50
155	7410	700222526H1	SATMON011	g1619336	BLASTX	149	1e-21	56
156	7410	700347409H1	SATMON023	g40968	BLASTX	83	1e-16	55
157	28069	LIB189-001-Q1-E1-D4	LIB189	g1789791	BLASTX	281	1e-48	57

putative dehydroquinase dehydratase-maize

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
158	-700237972	700237972H1	SATMON010	g535771	BLASTX	136	1e-18	69
159	11022	700155850H1	SATMON007	g535771	BLASTX	247	1e-27	65

dehydroquinase dehydratase-soybean

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
160	4639	700834936H1	SOYMON019	g535771	BLASTX	150	1e-20	55

Shikimate dehydrogenase-maize

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
158	-700237972	700237972H1	SATMON010	g535771	BLASTX	136	1e-18	69
159	11022	700155850H1	SATMON007	g535771	BLASTX	247	1e-27	65

Shikimate dehydrogenase-soybean

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
160	4639	700834936H1	SOYMON019	g535771	BLASTX	150	1e-20	55

Shikimate kinase-maize

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
161	-700050913	700050913H1	SATMON003	g19348	BLASTN	403	1e-28	69
162	-700104390	700104390H1	SATMON010	g19348	BLASTN	446	1e-26	64
163	-700452495	700452495H1	SATMON028	g19349	BLASTX	81	1e-13	57
164	-700619865	700619865H1	SATMON034	g19349	BLASTX	142	1e-12	65
165	15996	700030278H1	SATMON003	g19349	BLASTX	219	1e-33	66
166	15996	700257047H1	SATMON017	g19348	BLASTN	399	1e-32	66
167	15996	700237902H1	SATMON010	g19348	BLASTN	472	1e-28	64
168	15996	700155641H1	SATMON007	g19348	BLASTN	438	1e-27	66
169	15996	700224589H1	SATMON011	g19348	BLASTN	447	1e-27	64
170	18563	700205659H1	SATMON003	g19348	BLASTN	443	1e-39	67
171	18563	700243143H1	SATMON010	g19349	BLASTX	274	1e-31	64
172	18563	700264692H1	SATMON017	g19348	BLASTN	501	1e-31	63
173	18563	700106054H1	SATMON010	g19348	BLASTN	280	1e-27	63
174	18563	700026972H1	SATMON003	g19349	BLASTX	159	1e-26	66
175	18563	700160974H1	SATMON012	g19349	BLASTX	167	1e-17	57
176	6303	700088964H1	SATMON011	g19348	BLASTN	470	1e-28	62
177	6303	700572756H1	SATMON030	g19349	BLASTX	113	1e-18	60
178	15635	LIB36-001-Q1-E1-F1	LIB36	g19349	BLASTX	149	1e-28	31
179	18563	LIB3066-029-Q1-K1-G8	LIB3066	g19348	BLASTN	870	1e-63	67

Shikimate kinase-soybean

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
180	-700568344	700568344H1	SOYMON002	g19349	BLASTX	126	1e-15	42
181	-700792015	700792015H1	SOYMON011	g19348	BLASTN	652	1e-45	72
182	18190	700977239H1	SOYMON009	g19349	BLASTX	97	1e-10	41
183	18190	LIB3055-003-Q1-N1-D12	LIB3055	g19349	BLASTX	139	1e-28	36

Enolpyruvylshikimate-P-synthase-soybean

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
184	-700831419	700831419H1	SOYMON019	g169190	BLASTN	453	1e-50	80
185	-700845353	700845353H1	SOYMON021	g170373	BLASTN	629	1e-43	76
186	-700891187	700891187H1	SOYMON024	g170373	BLASTN	620	1e-42	74
187	-700976722	700976722H1	SOYMON009	g170373	BLASTN	774	1e-55	75
188	-700997285	700997285H1	SOYMON018	g170374	BLASTX	124	1e-11	86
189	-701048471	701048471H1	SOYMON032	g170228	BLASTN	886	1e-64	82
190	-701206839	701206839H1	SOYMON035	g17815	BLASTX	154	1e-14	88
191	17068	700942983H1	SOYMON024	g169190	BLASTN	571	1e-58	82
192	17068	701006194H1	SOYMON019	g169190	BLASTN	349	1e-53	79
193	18050	700906275H1	SOYMON022	g169190	BLASTN	868	1e-63	81
194	18050	701134508H1	SOYMON038	g169190	BLASTN	457	1e-60	80
195	3411	700556807H1	SOYMON001	g169190	BLASTN	568	1e-77	83
196	3411	700565035H1	SOYMON002	g169190	BLASTN	913	1e-67	79
197	3411	701008536H1	SOYMON019	g169190	BLASTN	622	1e-56	80
198	3411	701107917H1	SOYMON036	g170228	BLASTN	498	1e-32	84

Chorismate synthase-maize

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
199	-700104711	700104711H1	SATMON010	g976374	BLASTN	490	1e-30	70
200	10770	700092595H1	SATMON008	g410484	BLASTX	207	1e-21	70
201	10770	700088420H1	SATMON011	g410484	BLASTX	191	1e-19	68
202	10770	700333085H1	SATMON019	g410484	BLASTX	104	1e-13	67
203	2026	700282007H1	SATMON022	g410481	BLASTN	884	1e-64	77
204	2026	700077339H1	SATMON007	g410481	BLASTN	612	1e-59	75
205	2026	700571731H1	SATMON030	g410481	BLASTN	670	1e-54	77
206	2026	700348949H1	SATMON023	g410481	BLASTN	463	1e-53	77
207	2026	700090790H1	SATMON011	g18255	BLASTN	694	1e-49	71
208	2026	700236685H1	SATMON010	g18255	BLASTN	704	1e-49	77
209	2026	700166396H1	SATMON013	g410481	BLASTN	674	1e-47	76
210	2026	700466807H1	SATMON025	g18255	BLASTN	452	1e-43	71
211	2026	700335877H1	SATMON019	g410481	BLASTN	532	1e-35	74
212	4211	700259039H1	SATMON017	g18256	BLASTX	167	1e-18	60
213	4211	700457104H1	SATMON029	g410484	BLASTX	186	1e-18	75
214	4211	700153433H1	SATMON007	g410482	BLASTX	114	1e-14	68
215	4211	700073550H1	SATMON007	g18256	BLASTX	147	1e-13	61
216	4211	700224255H1	SATMON011	g18255	BLASTN	290	1e-13	67
217	4211	700440561H1	SATMON026	g410482	BLASTX	115	1e-8	66
218	9237	700105367H1	SATMON010	g410483	BLASTN	773	1e-55	73
219	9237	700337228H1	SATMON020	g18255	BLASTN	776	1e-55	73
220	9237	700159709H1	SATMON012	g18255	BLASTN	742	1e-53	76
221	9237	700242181H1	SATMON010	g410483	BLASTN	588	1e-40	71
222	9237	700168082H1	SATMON013	g18255	BLASTN	521	1e-34	73
223	9237	700169319H1	SATMON013	g18255	BLASTN	465	1e-29	78
224	9237	700172250H1	SATMON013	g18255	BLASTN	308	1e-15	71
225	9237	700584289H1	SATMON031	g410484	BLASTX	93	1e-8	69
226	-L1434254	LIB143-041-Q1-E1-F6	LIB143	g18255	BLASTN	541	1e-34	68
227	-L30781785	LIB3078-015-Q1-K1-E5	LIB3078	g410481	BLASTN	766	1e-55	67
228	2026	LIB3066-009-Q1-K1-C12	LIB3066	g410481	BLASTN	1124	1e-84	75
229	2026	LIB3078-012-Q1-K1-C8	LIB3078	g410481	BLASTN	992	1e-73	78
230	2026	LIB84-014-Q1-E1-D4	LIB84	g410481	BLASTN	517	1e-32	77
231	9237	LIB3067-014-Q1-K1-C5	LIB3067	g410484	BLASTX	219	1e-39	74

Chorismate synthase-soybean

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
232	-700829731	700829731H1	SOYMON019	g410482	BLASTX	163	1e-15	81
233	-700867002	700867002H1	SOYMON016	g18255	BLASTN	871	1e-63	82
234	-700941055	700941055H1	SOYMON024	g18257	BLASTN	621	1e-42	73
235	-700993596	700993596H1	SOYMON011	g18255	BLASTN	648	1e-56	80
236	-701107074	701107074H1	SOYMON036	g410482	BLASTX	119	1e-9	77
237	-701215158	701215158H1	SOYMON035	g18255	BLASTN	404	1e-33	82
238	11113	700792218H1	SOYMON011	g18257	BLASTN	549	1e-36	71
239	11113	701037327H1	SOYMON029	g18257	BLASTN	535	1e-35	70
240	20587	701042739H1	SOYMON029	g18257	BLASTN	537	1e-35	70
241	20587	700565645H1	SOYMON002	g18257	BLASTN	427	1e-31	73
242	24472	701053135H1	SOYMON032	g18255	BLASTN	927	1e-68	78
243	24472	700875233H1	SOYMON018	g410481	BLASTN	843	1e-61	81
244	6572	700652322H1	SOYMON003	g18255	BLASTN	722	1e-65	82

245	6572	701107063H1	SOYMON036	g18255	BLASTN	451	1e-58	81
246	6572	701139518H1	SOYMON038	g18255	BLASTN	682	1e-48	80
247	6572	700653111H1	SOYMON003	g410481	BLASTN	585	1e-39	81
248	6572	701008289H1	SOYMON019	g410481	BLASTN	545	1e-36	76
249	6572	701124777H1	SOYMON037	g18255	BLASTN	446	1e-27	80
250	6572	700556802H1	SOYMON001	g410482	BLASTX	161	1e-19	80
251	6572	700834126H1	SOYMON019	g410482	BLASTX	131	1e-16	77
252	6572	700645571H1	SOYMON009	g410482	BLASTX	172	1e-16	87
253	6572	700834378H1	SOYMON019	g18255	BLASTN	154	1e-15	77
254	6572	700990811H1	SOYMON011	g410484	BLASTX	107	1e-9	69
255	6572	LIB3030-002-Q1-B1-F12	LIB3030	g18255	BLASTN	854	1e-62	77

Chorismate mutase-maize

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
256	-700050713	700050713H1	SATMON003	g429153	BLASTX	159	1e-23	81
257	-700239884	700239884H1	SATMON010	g429153	BLASTX	146	1e-13	40
258	-700573382	700573382H1	SATMON030	g429152	BLASTN	349	1e-18	72
259	25556	700343477H1	SATMON021	g2352928	BLASTN	502	1e-35	70
260	25556	700194568H1	SATMON014	g429153	BLASTX	209	1e-21	65
261	25556	700196845H1	SATMON014	g429153	BLASTX	97	1e-10	46
262	32994	700089092H1	SATMON011	g429153	BLASTX	110	1e-15	48
263	32994	700203014H1	SATMON003	g429153	BLASTX	117	1e-9	43
264	3773	700048888H1	SATMON003	g429153	BLASTX	91	1e-24	72
265	3773	700090144H1	SATMON011	g429153	BLASTX	182	1e-18	55
266	3773	700221335H1	SATMON011	g429153	BLASTX	109	1e-10	49
267	8783	700574324H2	SATMON030	g429152	BLASTN	290	1e-13	73
268	8783	700164106H1	SATMON013	g429153	BLASTX	87	1e-9	58
269	25556	LIB3062-059-Q1-K1-H12	LIB3062	g2352928	BLASTN	502	1e-33	70
270	25556	LIB3062-023-Q1-K1-F12	LIB3062	g2352928	BLASTN	493	1e-32	70
271	25556	LIB3059-001-Q1-K2-E4	LIB3059	g2352928	BLASTN	443	1e-28	68
272	25556	LIB3069-042-Q1-K1-E10	LIB3069	g429152	BLASTN	260	1e-10	71
273	32994	LIB189-013-Q1-E1-G8	LIB189	g429153	BLASTX	150	1e-36	45
274	3773	LIB3062-011-Q1-K1-E11	LIB3062	g429152	BLASTN	621	1e-41	73
275	3773	LIB3061-006-Q1-K1-B5	LIB3061	g429152	BLASTN	408	1e-40	72
276	3773	LIB3061-035-Q1-K1-B12	LIB3061	g429152	BLASTN	319	1e-15	77
277	8783	LIB3059-017-Q1-K1-C2	LIB3059	g429152	BLASTN	357	1e-18	66

Chorismate mutase -soybean

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
278	-700649675	700649675H1	SOYMON003	g429153	BLASTX	207	1e-21	62
279	24797	701123012H1	SOYMON037	g3021541	BLASTN	525	1e-37	75
280	24797	701149634H1	SOYMON031	g3021541	BLASTN	520	1e-36	75
281	7212	700646325H1	SOYMON013	g429153	BLASTX	116	1e-8	65
282	-GM22414	LIB3030-009-Q1-B1-B5	LIB3030	g429153	BLASTX	134	1e-39	59
283	-GM29291	LIB3050-017-Q1-E1-E9	LIB3050	g2352930	BLASTN	473	1e-30	66
284	-GM30547	LIB3050-004-Q1-E1-G9	LIB3050	g429153	BLASTX	153	1e-29	64

tyrosine transaminase-maize

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
285	16305	700337451H1	SATMON020	g408894	BLASTX	134	1e-11	33
286	16305	700340103H1	SATMON020	g408894	BLASTX	93	1e-10	39

putative tyrosine transaminase-maize

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
287	14653	700220061H1	SATMON011	g2842484	BLASTX	349	1e-41	70
288	22902	700106817H1	SATMON010	g2842484	BLASTX	331	1e-38	58
289	22902	701181789H1	SATMONN06	g2842484	BLASTX	278	1e-31	62
290	6658	700442825H1	SATMON026	g2842484	BLASTX	209	1e-26	62
291	6658	700152030H1	SATMON007	g2842484	BLASTX	128	1e-18	53
292	6658	LIB3066-020-Q1-K1-F1	LIB3066	g2842484	BLASTX	348	1e-64	57

putative tyrosine transaminase-soybean

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
293	-700848909	700848909H1	SOYMON021	g2842484	BLASTX	281	1e-31	62
294	-700900410	700900410H1	SOYMON027	g2842484	BLASTX	119	1e-11	42
295	17700	700905146H1	SOYMON022	g2842484	BLASTX	315	1e-36	67
296	2201	700730931H1	SOYMON009	g2842484	BLASTX	174	1e-17	43
297	2201	700752627H1	SOYMON014	g2842484	BLASTX	102	1e-12	41
298	94	700658292H1	SOYMON004	g2842484	BLASTX	100	1e-18	53
299	6064	LIB3056-002-Q1-B1-A8	LIB3056	g2842484	BLASTX	124	1e-25	34
300	94	LIB3051-101-Q1-K1-H3	LIB3051	g2842484	BLASTX	205	1e-37	44

Transaminase A-maize

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
301	-700028003	700028003H1	SATMON003	g63066	BLASTX	125	1e-10	79
302	-700072842	700072842H1	SATMON007	g1001121	BLASTX	259	1e-28	50
303	-700194011	700194011H1	SATMON014	g435456	BLASTN	324	1e-18	73
304	-700196486	700196486H1	SATMON014	g20599	BLASTX	68	1e-10	74
305	-700331820	700331820H1	SATMON019	g20600	BLASTN	1192	1e-90	90
306	-700454550	700454550H1	SATMON029	g435458	BLASTN	198	1e-20	82
307	-700454567	700454567H1	SATMON029	g435458	BLASTN	333	1e-24	82
308	-700454642	700454642H1	SATMON029	g435458	BLASTN	269	1e-23	89
309	-700454849	700454849H1	SATMON029	g435458	BLASTN	318	1e-26	87
310	-700468560	700468560H1	SATMON025	g3328816	BLASTX	139	1e-19	58
311	-700476413	700476413H1	SATMON025	g2984217	BLASTX	156	1e-22	52
312	-700615109	700615109H1	SATMON033	g20598	BLASTN	256	1e-17	81
313	-701161385	701161385H1	SATMONN04	g435458	BLASTN	523	1e-45	80
314	10165	700341126H1	SATMON020	g20596	BLASTN	743	1e-71	91
315	10165	700160220H1	SATMON012	g20596	BLASTN	769	1e-55	92
316	10165	700158802H1	SATMON012	g20596	BLASTN	617	1e-42	94
317	10192	700204319H1	SATMON003	g2984217	BLASTX	148	1e-13	55
318	10329	700095671H1	SATMON008	g20600	BLASTN	816	1e-59	87
319	10329	700214146H1	SATMON016	g20596	BLASTN	610	1e-42	88

320	10329	700041823H1	SATMON004	g20596	BLASTN	615	1e-42	78
321	10329	700094321H1	SATMON008	g20596	BLASTN	559	1e-40	88
322	1148	700089060H1	SATMON011	g633094	BLASTN	1397	1e-107	92
323	1148	700044414H1	SATMON004	g633094	BLASTN	1272	1e-97	92
324	1148	700101429H1	SATMON009	g633094	BLASTN	1221	1e-92	91
325	1148	700221366H1	SATMON011	g633094	BLASTN	1205	1e-91	94
326	1148	700101604H1	SATMON009	g633094	BLASTN	1167	1e-88	89
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328	1148	700157048H1	SATMON012	g633094	BLASTN	1121	1e-84	93
329	1148	700581463H1	SATMON031	g633094	BLASTN	1124	1e-84	90
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331	1148	700432477H1	SATMONN01	g633094	BLASTN	1050	1e-78	90
332	1148	700154706H1	SATMON007	g633094	BLASTN	997	1e-74	90
333	1148	700043761H1	SATMON004	g633094	BLASTN	905	1e-66	92
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335	1148	700424076H1	SATMONN01	g633094	BLASTN	228	1e-19	87
336	1148	701166426H1	SATMONN04	g633094	BLASTN	221	1e-16	79
337	16872	700211160H1	SATMON016	g633094	BLASTN	482	1e-56	88
338	16872	700043705H1	SATMON004	g633094	BLASTN	293	1e-42	85
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342	17829	700581970H1	SATMON031	g1001309	BLASTX	107	1e-11	53
343	18047	700206971H1	SATMON003	g1103380	BLASTX	107	1e-12	53
344	19241	700472363H1	SATMON025	g20598	BLASTN	1010	1e-81	89
345	19241	700472263H1	SATMON025	g20598	BLASTN	916	1e-78	89
346	19241	700806145H1	SATMON036	g20598	BLASTN	947	1e-74	92
347	319	700076939H1	SATMON007	g20598	BLASTN	1102	1e-83	89
348	319	700349974H1	SATMON023	g20598	BLASTN	1018	1e-80	84
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352	319	700258893H1	SATMON017	g20598	BLASTN	897	1e-73	89
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354	319	700806537H1	SATMON036	g20598	BLASTN	949	1e-70	87
355	319	700450338H1	SATMON028	g20598	BLASTN	912	1e-67	85
356	319	700806243H1	SATMON036	g20598	BLASTN	782	1e-66	87
357	319	700263732H1	SATMON017	g435456	BLASTN	662	1e-61	86
358	319	700806094H1	SATMON036	g20598	BLASTN	375	1e-59	91
359	319	700152610H1	SATMON007	g20598	BLASTN	806	1e-58	85
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361	319	700349161H1	SATMON023	g20598	BLASTN	270	1e-30	87
362	319	700805964H1	SATMON036	g20598	BLASTN	463	1e-29	79
363	319	700450544H1	SATMON028	g20598	BLASTN	280	1e-27	86
364	319	700618252H1	SATMON033	g20598	BLASTN	407	1e-26	86
365	319	700615189H1	SATMON033	g20598	BLASTN	309	1e-25	87
366	319	700264196H1	SATMON017	g20598	BLASTN	412	1e-25	84
367	4431	700211615H1	SATMON016	g1001309	BLASTX	96	1e-9	32
368	541	700073508H1	SATMON007	g633094	BLASTN	1388	1e-106	91
369	541	700098793H1	SATMON009	g633094	BLASTN	1329	1e-101	90
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372	541	700799335H1	SATMON036	g633094	BLASTN	1216	1e-92	95
373	541	700446909H1	SATMON027	g633094	BLASTN	1154	1e-87	91

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377	541	700576310H1	SATMON030	g633094	BLASTN	1107	1e-83	91
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384	541	700446192H1	SATMON027	g633094	BLASTN	774	1e-55	92
385	541	700614693H1	SATMON033	g633094	BLASTN	600	1e-54	80
386	7402	700439746H1	SATMON026	g20596	BLASTN	1353	1e-103	97
387	7402	700621225H1	SATMON034	g20596	BLASTN	709	1e-72	97
388	7402	700456918H1	SATMON029	g20596	BLASTN	968	1e-71	95
389	7402	700453876H1	SATMON029	g20600	BLASTN	761	1e-54	96
390	7402	700623616H1	SATMON034	g20596	BLASTN	432	1e-39	96
391	7402	700454592H1	SATMON029	g20600	BLASTN	380	1e-30	81
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393	7482	700197666H1	SATMON014	g2621088	BLASTX	145	1e-24	55
394	7482	700615228H1	SATMON033	g3328816	BLASTX	201	1e-20	61
395	7482	700030129H1	SATMON003	g3328816	BLASTX	178	1e-17	56
396	7482	700579227H1	SATMON031	g2621088	BLASTX	132	1e-15	44
397	786	700476002H1	SATMON025	g20598	BLASTN	1119	1e-90	92
398	786	700461103H1	SATMON033	g20598	BLASTN	1196	1e-90	91
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402	786	700452647H1	SATMON028	g20598	BLASTN	1115	1e-84	88
403	786	700194349H1	SATMON014	g20598	BLASTN	1115	1e-84	92
404	786	700472225H1	SATMON025	g20598	BLASTN	645	1e-82	86
405	786	700461203H1	SATMON033	g20598	BLASTN	1019	1e-82	90
406	786	700581588H1	SATMON031	g20598	BLASTN	561	1e-79	90
407	786	700194330H1	SATMON014	g20598	BLASTN	1043	1e-78	90
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409	786	700157347H1	SATMON012	g20598	BLASTN	1049	1e-78	90
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411	786	700160255H1	SATMON012	g20598	BLASTN	1040	1e-77	93
412	786	700582138H1	SATMON031	g20598	BLASTN	885	1e-75	88
413	786	700197148H1	SATMON014	g20598	BLASTN	1007	1e-75	90
414	786	700159366H1	SATMON012	g20598	BLASTN	1016	1e-75	91
415	786	701184326H1	SATMONN06	g20598	BLASTN	815	1e-72	89
416	786	700159491H1	SATMON012	g20598	BLASTN	979	1e-72	93
417	786	700104663H1	SATMON010	g20598	BLASTN	966	1e-71	86
418	786	700195003H1	SATMON014	g20598	BLASTN	779	1e-69	86
419	786	700218254H1	SATMON016	g20598	BLASTN	942	1e-69	89
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421	786	700157772H1	SATMON012	g20598	BLASTN	887	1e-65	90
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423	786	700800486H1	SATMON036	g20598	BLASTN	868	1e-63	91
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426	786	700451832H1	SATMON028	g20598	BLASTN	501	1e-58	88
427	786	700799994H1	SATMON036	g20598	BLASTN	570	1e-55	91

428	786	700801486H1	SATMON036	g20598	BLASTN	750	1e-53	91
429	786	700802086H1	SATMON036	g20598	BLASTN	459	1e-51	89
430	786	700477105H1	SATMON025	g20598	BLASTN	708	1e-50	90
431	786	700260426H1	SATMON017	g20598	BLASTN	702	1e-49	84
432	786	700799811H1	SATMON036	g20598	BLASTN	409	1e-48	84
433	786	700427005H1	SATMONN01	g20598	BLASTN	691	1e-48	89
434	786	700803487H1	SATMON036	g20598	BLASTN	423	1e-46	83
435	786	700262695H1	SATMON017	g20598	BLASTN	367	1e-43	89
436	786	700471602H1	SATMON025	g20598	BLASTN	601	1e-41	90
437	786	701185813H2	SATMONN06	g20598	BLASTN	320	1e-39	83
438	786	700196744H1	SATMON014	g20598	BLASTN	490	1e-32	92
439	786	701184204H1	SATMONN06	g20598	BLASTN	247	1e-10	78
440	786	700622453H1	SATMON034	g20598	BLASTN	230	1e-8	79
441	786	700618768H1	SATMON034	g20598	BLASTN	230	1e-8	79
442	-L30591931	LIB3059-009-Q1-K1-C12	LIB3059	g20596	BLASTN	1989	1e-157	95
443	-L30593805	LIB3059-022-Q1-K1-H6	LIB3059	g20596	BLASTN	377	1e-56	79
444	-L30596704	LIB3059-055-Q1-K1-E5	LIB3059	g20596	BLASTN	733	1e-52	89
445	-L30624957	LIB3062-040-Q1-K1-H1	LIB3062	g633095	BLASTX	112	1e-27	56
446	-L30671766	LIB3067-014-Q1-K1-B8	LIB3067	g20596	BLASTN	1132	1e-122	86
447	-L30693715	LIB3069-012-Q1-K1-F3	LIB3069	g142538	BLASTX	98	1e-24	47
448	10329	LIB3079-007-Q1-K1-B3	LIB3079	g20596	BLASTN	1201	1e-97	87
449	10329	LIB143-052-Q1-E1-E4	LIB143	g20596	BLASTN	751	1e-53	86
450	1148	LIB3078-040-Q1-K1-H1	LIB3078	g633094	BLASTN	1675	1e-130	87
451	1148	LIB3062-040-Q1-K1-H3	LIB3062	g633094	BLASTN	1310	1e-100	88
452	1148	LIB143-054-Q1-E1-F1	LIB143	g633094	BLASTN	1234	1e-94	88
453	1148	LIB83-001-Q1-E1-A10	LIB83	g633094	BLASTN	1030	1e-77	81
454	16872	LIB36-018-Q1-E1-D12	LIB36	g633094	BLASTN	542	1e-69	85
455	25099	LIB3059-012-Q1-K1-G3	LIB3059	g1001309	BLASTX	130	1e-36	38
456	319	LIB143-022-Q1-E1-G3	LIB143	g20598	BLASTN	1698	1e-135	89
457	319	LIB143-048-Q1-E1-G12	LIB143	g20598	BLASTN	1562	1e-126	87
458	319	LIB143-001-Q1-E1-H6	LIB143	g20598	BLASTN	1462	1e-113	90
459	319	LIB143-002-Q1-E1-H2	LIB143	g20598	BLASTN	484	1e-66	88
460	32047	LIB148-034-Q1-E1-F3	LIB148	g435456	BLASTN	262	1e-12	68
461	32047	LIB148-032-Q1-E1-H8	LIB148	g435456	BLASTN	255	1e-11	71
462	541	LIB3062-033-Q1-K1-G2	LIB3062	g633094	BLASTN	1706	1e-133	90
463	541	LIB3062-033-Q1-K1-G3	LIB3062	g633094	BLASTN	1123	1e-94	84
464	541	LIB3060-005-Q1-K1-C1	LIB3060	g633094	BLASTN	1061	1e-90	84
465	7402	LIB3059-004-Q1-K1-F4	LIB3059	g20596	BLASTN	1461	1e-142	92
466	7482	LIB3059-049-Q1-K1-E5	LIB3059	g2621088	BLASTX	138	1e-48	51
467	786	LIB3061-042-Q1-K1-E8	LIB3061	g20598	BLASTN	1811	1e-142	88
468	786	LIB143-040-Q1-E1-D11	LIB143	g20598	BLASTN	1462	1e-113	92
469	786	LIB143-030-Q1-E1-D9	LIB143	g20598	BLASTN	1141	1e-101	90
470	786	LIB3068-035-Q1-K1-A4	LIB3068	g20598	BLASTN	533	1e-99	78
471	786	LIB143-017-Q1-E1-C8	LIB143	g20598	BLASTN	678	1e-92	82
472	786	LIB143-030-Q1-E1-D11	LIB143	g20598	BLASTN	1165	1e-88	86
473	786	LIB3061-048-Q1-K1-D7	LIB3061	g20598	BLASTN	299	1e-15	78
474	786	LIB3059-056-Q1-K1-B1	LIB3059	g20598	BLASTN	283	1e-12	74

Transaminase A-soybean

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
475	-700668054	700668054H1	SOYMON006	g3328816	BLASTX	172	1e-16	53
476	-700685655	700685655H1	SOYMON008	g387106	BLASTX	165	1e-15	62

477	-700729138	700729138H1	SOYMON009	g2621088	BLASTX	136	1e-17	47
478	-700734818	700734818H1	SOYMON010	g3201622	BLASTX	234	1e-25	54
479	-700787411	700787411H2	SOYMON011	g20598	BLASTN	908	1e-66	90
480	-700868646	700868646H1	SOYMON016	g435458	BLASTN	513	1e-33	75
481	-700874369	700874369H1	SOYMON018	g2654093	BLASTN	808	1e-63	90
482	-700974412	700974412H1	SOYMON005	g169914	BLASTN	249	1e-11	83
483	-701009475	701009475H1	SOYMON019	g1001309	BLASTX	111	1e-15	49
484	-701050301	701050301H1	SOYMON032	g169914	BLASTN	263	1e-11	75
485	-701061267	701061267H1	SOYMON033	g169914	BLASTN	235	1e-35	88
486	-701129551	701129551H1	SOYMON037	g169914	BLASTN	1232	1e-93	93
487	13413	700904367H1	SOYMON022	g1001121	BLASTX	231	1e-24	52
488	13413	700895714H1	SOYMON027	g2266762	BLASTX	175	1e-22	49
489	13413	700727795H1	SOYMON009	g1001121	BLASTX	190	1e-19	48
490	13503	700974712H1	SOYMON005	g169914	BLASTN	1358	1e-104	99
491	13503	700895483H1	SOYMON027	g169914	BLASTN	1236	1e-94	97
492	13503	700846207H1	SOYMON021	g169914	BLASTN	1136	1e-85	94
493	14358	700909477H1	SOYMON022	g710595	BLASTN	1309	1e-100	98
494	14358	700732673H1	SOYMON010	g710595	BLASTN	1296	1e-99	98
495	14358	700890192H1	SOYMON024	g710595	BLASTN	913	1e-83	98
496	14358	700727008H1	SOYMON009	g710595	BLASTN	553	1e-55	99
497	15432	700567458H1	SOYMON002	g1001309	BLASTX	115	1e-8	31
498	15529	701045375H1	SOYMON032	g3201622	BLASTX	189	1e-19	55
499	15529	700567374H1	SOYMON002	g3201622	BLASTX	186	1e-18	55
500	15529	701102885H1	SOYMON028	g3201622	BLASTX	172	1e-16	56
501	15529	701213187H1	SOYMON035	g3201622	BLASTX	174	1e-16	55
502	15529	701055675H1	SOYMON032	g3201622	BLASTX	166	1e-15	60
503	15529	701052631H1	SOYMON032	g3201622	BLASTX	159	1e-14	53
504	15529	701213639H1	SOYMON035	g3201622	BLASTX	110	1e-13	59
505	1566	700651242H1	SOYMON003	g2654093	BLASTN	1433	1e-146	98
506	1566	700661083H1	SOYMON005	g2654093	BLASTN	898	1e-102	95
507	1566	700668434H1	SOYMON006	g2654093	BLASTN	1289	1e-98	99
508	1566	700677640H1	SOYMON007	g2654093	BLASTN	758	1e-97	99
509	1566	700655909H1	SOYMON004	g2654093	BLASTN	730	1e-95	100
510	1566	700660728H1	SOYMON005	g2654093	BLASTN	634	1e-81	90
511	1566	700807523H1	SOYMON016	g2654093	BLASTN	478	1e-31	87
512	16634	700660070H1	SOYMON004	g2621088	BLASTX	111	1e-20	54
513	16634	700746670H1	SOYMON013	g2621088	BLASTX	118	1e-18	53
514	1703	700749933H1	SOYMON013	g2654093	BLASTN	1385	1e-106	100
515	1703	700793749H1	SOYMON017	g2654093	BLASTN	1370	1e-105	100
516	1703	701127031H1	SOYMON037	g2654093	BLASTN	716	1e-94	96
517	1703	700997259H1	SOYMON018	g2654093	BLASTN	1089	1e-81	97
518	1703	700670783H1	SOYMON006	g2654093	BLASTN	767	1e-79	93
519	25132	700678487H1	SOYMON007	g2654093	BLASTN	1175	1e-104	98
520	25132	701049020H1	SOYMON032	g2654093	BLASTN	1260	1e-96	100
521	25542	701151325H1	SOYMON031	g1001309	BLASTX	96	1e-15	51
522	25542	700964436H1	SOYMON022	g1001309	BLASTX	107	1e-13	51
523	26671	701106241H1	SOYMON036	g1001309	BLASTX	121	1e-9	39
524	26671	701149504H1	SOYMON031	g1001309	BLASTX	122	1e-9	36
525	27066	700605347H2	SOYMON004	g169914	BLASTN	1147	1e-104	99
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527	6297	700971234H1	SOYMON005	g169914	BLASTN	1303	1e-99	99
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563	7585	700787774H2	SOYMON011	g2654093	BLASTN	943	1e-82	96
564	7585	701069589H1	SOYMON034	g2654093	BLASTN	539	1e-81	93
565	7585	700663096H1	SOYMON005	g2654093	BLASTN	498	1e-80	95
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571	7585	700995223H1	SOYMON011	g2654093	BLASTN	765	1e-68	89
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574	7585	700888603H1	SOYMON024	g2654093	BLASTN	865	1e-63	96
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576	9138	700562918H1	SOYMON002	g152149	BLASTX	195	1e-26	61
577	9138	700654444H1	SOYMON004	g152149	BLASTX	191	1e-24	60
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580	9138	701037102H1	SOYMON029	g152149	BLASTX	123	1e-16	53
581	9138	701119543H1	SOYMON037	g3257794	BLASTX	152	1e-13	58

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584	-GM25144	LIB3040-027-Q1-E1-F2	LIB3040	g2654093	BLASTN	526	1e-65	85
585	-GM41298	LIB3051-109-Q1-K1-F6	LIB3051	g2654093	BLASTN	207	1e-29	83
586	14358	LIB3051-106-Q1-K1-G8	LIB3051	g710595	BLASTN	2246	1e-178	99
587	25132	LIB3051-063-Q1-K1-D12	LIB3051	g2654093	BLASTN	1347	1e-103	96
588	32509	LIB3056-012-Q1-N1-C3	LIB3056	g2648397	BLASTX	152	1e-29	43
589	6297	LIB3055-010-Q1-N1-G6	LIB3055	g169914	BLASTN	1721	1e-134	99
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592	6297	LIB3049-021-Q1-E1-C8	LIB3049	g169914	BLASTN	864	1e-63	91
593	7585	LIB3051-105-Q1-K1-F8	LIB3051	g2654093	BLASTN	2108	1e-167	99
594	7585	LIB3028-010-Q1-B1-C7	LIB3028	g2654093	BLASTN	1973	1e-158	97
595	7585	LIB3030-001-Q1-B1-B7	LIB3030	g2654093	BLASTN	1117	1e-138	95
596	7585	LIB3051-040-Q1-K1-D4	LIB3051	g2654093	BLASTN	1166	1e-116	94
597	9138	LIB3065-001-Q1-N1-G1	LIB3065	g152149	BLASTX	168	1e-38	52

4-hydroxyphenylpyruvate dioxygenase-maize								
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599	-700578555	700578555H1	SATMON031	g2695710	BLASTX	144	1e-12	71
600	31568	LIB143-034-Q1-E1-C6	LIB143	g2695709	BLASTN	650	1e-47	74

4-hydroxyphenylpyruvate dioxygenase-soybean								
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602	11733	700833534H1	SOYMON019	g2145039	BLASTX	124	1e-17	60
603	13818	700961605H1	SOYMON022	g2145038	BLASTN	785	1e-56	82
604	13818	700906510H1	SOYMON022	g2145038	BLASTN	744	1e-53	82
605	-GM31671	LIB3051-002-Q1-E1-A1	LIB3051	g2145038	BLASTN	668	1e-44	74
606	-GM37087	LIB3051-068-Q1-K1-H8	LIB3051	g2695709	BLASTN	593	1e-50	76
607	11733	LIB3051-067-Q1-K1-E3	LIB3051	g2145038	BLASTN	726	1e-49	74

homogentisic acid dioxygenase-maize								
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609	-701185447	701185447H1	SATMONN06	g2832726	BLASTX	216	1e-28	51
610	12601	700578778H1	SATMON031	g2832726	BLASTX	307	1e-35	67
611	1732	700469334H1	SATMON025	g2832726	BLASTX	146	1e-23	52
612	1732	700469267H1	SATMON025	g2832726	BLASTX	122	1e-19	53
613	8522	700466728H1	SATMON025	g2832726	BLASTX	189	1e-19	53
614	8522	700257246H1	SATMON017	g2832726	BLASTX	182	1e-18	53
615	-L30683918	LIB3068-049-Q1-K1-D6	LIB3068	g1561616	BLASTX	158	1e-43	69

homogentisic acid dioxygenase-soybean

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618	24903	701204527H2	SOYMON035	g2832726	BLASTX	205	1e-21	54
619	24903	701106917H1	SOYMON036	g2832726	BLASTX	197	1e-20	54
620	24903	701204272H2	SOYMON035	g1561616	BLASTX	80	1e-10	67
621	26239	701208301H1	SOYMON035	g2832726	BLASTX	316	1e-36	69

geranylgeranylpyrophosphate synthase-maize

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622	-700165387	700165387H1	SATMON013	g1419758	BLASTX	119	1e-17	67
623	-700622762	700622762H1	SATMON034	g1722699	BLASTX	115	1e-10	65
624	-L30782383	LIB3078-012-Q1-K1-D3	LIB3078	g1063276	BLASTX	149	1e-46	55

geranylgeranylpyrophosphate synthase-soybean

Seq No.	Cluster ID	CloneID	Library	NCBI gi	Method	Score	P-value	%Ident
625	-700741352	700741352H1	SOYMON012	g1722699	BLASTX	154	1e-15	59
626	-701098728	701098728H2	SOYMON028	g643094	BLASTX	142	1e-26	69
627	-701210428	701210428H1	SOYMON035	g558924	BLASTN	639	1e-44	78

***Table Headings**

Cluster ID

A cluster ID is arbitrarily assigned to all of those clones which belong to the same cluster at a given stringency and a particular clone will belong to only one cluster at a given stringency.

- 5 If a cluster contains only a single clone (a “singleton”), then the cluster ID number will be negative, with an absolute value equal to the clone ID number of its single member. The cluster ID entries in the table refer to the cluster with which the particular clone in each row is associated.

Clone ID

The clone ID number refers to the particular clone in the PhytoSeq database. Each clone ID entry in the table refers to the clone whose sequence is used for (1) the sequence comparison whose scores are presented and/or (2) assignment to the particular cluster which is presented.

Note that a clone may be included in this table even if its sequence comparison scores fail to meet the minimum standards for similarity. In such a case, the clone is included due solely to its association with a particular cluster for which sequences of one or more other member clones possess the required level of similarity.

Library

The library ID refers to the particular cDNA library from which a given clone is obtained. Each cDNA library is associated with the particular tissue(s), line(s) and developmental stage(s) from which it is isolated.

NCBI gi

Each sequence in the GenBank public database is arbitrarily assigned a unique NCBI gi (National Center for Biotechnology Information GenBank Identifier) number. In this table, the

NCBI gi number which is associated (in the same row) with a given clone refers to the particular GenBank sequence which is used in the sequence comparison. This entry is omitted when a clone is included solely due to its association with a particular cluster.

Method

5 The entry in the “Method” column of the table refers to the type of BLAST search that is used for the sequence comparison. “CLUSTER” is entered when the sequence comparison scores for a given clone fail to meet the minimum values required for significant similarity. In such cases, the clone is listed in the table solely as a result of its association with a given cluster for which sequences of one or more other member clones possess the required level of similarity.

Score

Each entry in the “Score” column of the table refers to the BLAST score that is generated by sequence comparison of the designated clone with the designated GenBank sequence using the designated BLAST method. This entry is omitted when a clone is included solely due to its association with a particular cluster. If the program used to determine the hit is HMMSW then the score refers to HMMSW score.

P-Value

The entries in the P-Value column refer to the probability that such matches occur by chance.

%Ident

20 The entries in the “%Ident” column of the table refer to the percentage of identically matched nucleotides (or residues) that exist along the length of that portion of the sequences which is aligned by the BLAST comparison to generate the statistical scores presented. This entry is omitted when a clone is included solely due to its association with a particular cluster.

We claim:

1. A substantially purified nucleic acid molecule that encodes a maize or soybean tocopherol synthesis pathway enzyme or fragment thereof, wherein said maize or soybean tocopherol synthesis pathway enzyme is selected from the group consisting of:

5 (a) deoxyarabiono-heptulosonate-P-synthase or fragment thereof;

(b) putative deoxyarabiono-heptulosonate-P-synthase or fragment thereof;

(c) dehydroquate synthase or fragment thereof;

(d) dehydroquate dehydratase or fragment thereof;

(e) putative dehydroquate dehydratase or fragment thereof;

10 (f) shikimate dehydrogenase or fragment thereof;

(g) shikimate kinase or fragment thereof;

(h) enolpyruvylshikimate-P-synthase or fragment thereof;

(i) chorismate synthase or fragment thereof;

(j) chorismate mutase or fragment thereof;

15 (k) tyrosine transaminase or fragment thereof;

(l) putative tyrosine transaminase or fragment thereof;

(m) transaminase A or fragment thereof;

(n) putative transaminase A or fragment thereof;

(o) 4-hydroxyphenylpyruvate dioxygenase or fragment thereof;

20 (p) homogentisic acid dioxygenase or fragment thereof; and

(q) geranylgeranylpyrophosphate synthase or fragment thereof.

2. The substantially purified nucleic acid molecule according to claim 1, wherein said nucleic acid molecule comprises a nucleic acid sequence selected from the group consisting of SEQ ID NO: 1 through SEQ ID NO: 627.

3. A substantially purified maize or soybean tocopherol synthesis pathway enzyme or fragment thereof, wherein said maize or soybean tocopherol synthesis pathway enzyme is selected from the group consisting of:

- (a) deoxyarabiono-heptulosonate-P-synthase or fragment thereof;
- (b) putative deoxyarabiono-heptulosonate-P-synthase or fragment thereof;
- (c) dehydroquate synthase or fragment thereof;
- (d) dehydroquate dehydratase or fragment thereof;
- (e) putative dehydroquate dehydratase or fragment thereof;
- (f) shikimate dehydrogenase or fragment thereof;
- (g) shikimate kinase or fragment thereof;
- (h) enolpyruvylshikimate-P-synthase or fragment thereof;
- (i) chorismate synthase or fragment thereof;
- (j) chorismate mutase or fragment thereof;
- (k) tyrosine transaminase or fragment thereof;
- (l) putative tyrosine transaminase or fragment thereof;
- (m) transaminase A or fragment thereof;
- (n) putative transaminase A or fragment thereof;
- (o) 4-hydroxyphenylpyruvate dioxygenase or fragment thereof;
- (p) homogentisic acid dioxygenase or fragment thereof; and

(q) geranylgeranylpyrophosphate synthase or fragment thereof.

4. A substantially purified maize or soybean tocopherol synthesis pathway enzyme or fragment thereof according to claim 3, wherein said maize or soybean tocopherol synthesis pathway enzyme or fragment thereof is encoded by a nucleic acid molecule comprising a nucleic acid sequence selected from the group consisting of SEQ ID NO: 1 through SEQ ID NO: 627.

5. A substantially purified antibody or fragment thereof which is capable of specifically binding to a specific maize or soybean tocopherol synthesis pathway enzyme or fragment thereof according to claim 4.

6. A transformed plant having a nucleic acid molecule which comprises:

(A) an exogenous promoter region which functions in a plant cell to cause the production of a mRNA molecule;

(B) a structural nucleic acid molecule comprising a nucleic acid sequence selected from the group consisting of

(a) a nucleic acid sequence which encodes for a deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof;

(b) a nucleic acid sequence which encodes for a putative deoxyarabiono-heptulosonate-P-synthase enzyme or fragment thereof;

(c) a nucleic acid sequence which encodes for a dehydroquinate synthase enzyme or fragment thereof;

(d) a nucleic acid sequence which encodes for a dehydroquinase dehydratase enzyme or fragment thereof;

(e) a nucleic acid sequence which encodes for a putative dehydroquinase dehydratase enzyme or fragment thereof;

5 (f) a nucleic acid sequence which encodes for a shikimate dehydrogenase enzyme or fragment thereof;

(g) a nucleic acid sequence which encodes for a shikimate kinase enzyme or fragment thereof;

(h) a nucleic acid sequence which encodes for an enolpyruvylshikimate-P-synthase enzyme or fragment thereof;

(i) a nucleic acid sequence which encodes for a chorismate synthase enzyme or fragment thereof;

(j) a nucleic acid sequence which encodes for a chorismate mutase enzyme or fragment thereof;

(k) a nucleic acid sequence which encodes for a tyrosine transaminase enzyme or fragment thereof;

(l) a nucleic acid sequence which encodes for a putative Tyrosine transaminase enzyme or fragment thereof;

(m) a nucleic acid sequence which encodes for a transaminase A enzyme or fragment thereof;

(n) a nucleic acid sequence which encodes for a putative transaminase A enzyme or fragment thereof;

(o) a nucleic acid sequence which encodes for a 4-hydroxyphenylpyruvate dioxygenase enzyme or fragment thereof;

(p) a nucleic acid sequence which encodes for a homogentisic acid dioxygenase enzyme or fragment thereof; and

5 (q) a nucleic acid sequence which encodes for a geranylgeranylpyrophosphate synthase enzyme or fragment thereof;

(r) a nucleic acid sequence which is complementary to any of the nucleic acid sequences of (a) through (q); and

(C) a 3' non-translated sequence that functions in said plant cell to cause termination of transcription and addition of polyadenylated ribonucleotides to a 3' end of said mRNA molecule.

10 7. The transformed plant according to claim 6, wherein said structural gene is complementary to any of the nucleic acid sequences of (a) through (q).

15 8. A method for determining a level or pattern in a plant cell of a tocopherol synthesis pathway enzyme in a plant metabolic pathway comprising:

(A) incubating, under conditions permitting nucleic acid hybridization, a marker nucleic acid molecule, said marker nucleic acid molecule selected from the group of marker nucleic acid molecules which specifically hybridize to a nucleic acid molecule having the nucleic acid sequence of SEQ ID NO: 1 through SEQ ID NO: 627 or complements thereof, with a
20 complementary nucleic acid molecule obtained from said plant cell or plant tissue, wherein nucleic acid hybridization between said marker nucleic acid molecule and said complementary

nucleic acid molecule obtained from said plant cell or plant tissue permits the detection of an mRNA for said tocopherol synthesis pathway enzyme;

(B) permitting hybridization between said marker nucleic acid molecule and said complementary nucleic acid molecule obtained from said plant cell or plant tissue; and

5 (C) detecting the level or pattern of said complementary nucleic acid, wherein the detection of said complementary nucleic acid is predictive of the level or pattern of said tocopherol synthesis pathway enzyme in said plant metabolic pathway.

9. The method of claim 8, wherein said level or pattern is detected by *in situ* hybridization.

ABSTRACT

The present invention is in the field of plant biochemistry. More specifically the invention relates to nucleic acid sequences from plant cells, in particular, nucleic acid sequences from maize and soybean associated with the tocopherol synthesis pathway enzymes. The invention encompasses nucleic acid molecules that encode proteins and fragments of proteins. In addition, the invention also encompasses proteins and fragments of proteins so encoded and antibodies capable of binding these proteins or fragments. The invention also relates to methods of using the nucleic acid molecules, proteins and fragments of proteins and antibodies, for example for genome mapping, gene identification and analysis, plant breeding, preparation of constructs for use in plant gene expression and transgenic plants.

<110> Bhat, Barkur G.
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<120> Nucleic Acid Molecules And Other Molecules Associated With The
 Tocopherol Pathway

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<210> 8
 <211> 310
 <212> DNA
 <213> Zea mays

 <400> 8

 gggcttacag ttgaccaccc gataatgacg actactgact tctggacctc acacgagtgc 60
 cttctcttac cctacgagca gtctcttacc cgtaaagact ccaccagtgg ccttttctac 120
 gattgttcgg ccacatgct gtgggttggt gagcgcactc gtcaactcga tggagcgcat 180
 gttgaattcc ttctgtgtgt tgccaatcct cttggcataa agtgagcgac aaaatgaacc 240
 ccagtgaactt ggtgaagctg attgagattc tgaacccttc taacaaacct ggaaggatca 300
 ccataattac 310

<210> 9
 <211> 292
 <212> DNA
 <213> Zea mays

 <400> 9

 gtcgaccacc cgataatgac gactactgac ttctggacct cgcacgagtg ccttctotta 60
 ccctacgagc aggctcttac ccgtgaggat tccaccagtg gccttttcta tgattgittog 120
 gcccacatgt tgtgggttgg tgagcgact cgacaactcg atggagctca tgttgaattc 180
 ctccgtggtg ttgccaaccc tctgggcata aaggtgagcg acaaaatgaa cccagtgag 240
 ttggtgaagc tgattgatat tctgaaccct tcaaacaaac ctggaaggat ca 292

<210> 10
 <211> 332
 <212> DNA
 <213> Zea mays

 <400> 10

 aagcgcactc gtcaactcga tggagcgcac gttgaattcc ttccgtggtg tgccaatcct 60
 cttggcataa aggtgagcga caaaatgaac cccagtgact tggatgaagc gattgagatt 120
 ctgaaccctt caaacaacc tggaaggatc accataatta caaggatggg ggcagagaac 180
 atgagagtga agttgcctca tctcatccgt gctgttcgca atgctggatt aattgtcaca 240
 tggattactg atcctatgca tggaaacacc atcaaggcgc cttgtggcct gaagactcgt 300
 ccattcgact caattctggc tgaagtgcgc gc 332

<210> 11
 <211> 277
 <212> DNA
 <213> Zea mays

 <400> 11

 ggtgagcgca ctctcaact cgatggagcg catgttgaat tccttcgtgg tgttgccaat 60
 cctcttggca taaaggtgag cgacaaaatg aaccccagtg acttggtgaa gctgattgag 120
 attctgaacc cttcaacaa acctggaagg atcaccataa ttacaaggat gggggcagag 180
 aacatgagag tgaagttgcc tcatctcatc cgtgctgttc gcaatgctgg attaattgtc 240

acatggatta ctgacccat gcatggaaac accatca

277

<210> 12
<211> 272
<212> DNA
<213> Zea mays

<400> 12

attctggacc tcgcacgagt gccttctctt accctacgag caggatctga cccgtgagga 60
ttccagcagt ggccttttct atgattgttc ggcccagatg ttgtgggttg gtgagcgac 120
tcgacaactc gatggagctc atgttgaatt cctccgttgt gttgccaagc ctctgggcat 180
aaaggtgagc gagaaaatga agccgagtga gttggtgaag ctgattgata gtctgaacct 240
ttgaaacaaa gctggaagga tcagcatatt ac 272

<210> 13
<211> 218
<212> DNA
<213> Zea mays

<223> unsure at all n locations
<400> 13

gttcggccca catgctgttg gttggtgagc gcactcgtca actcgatgga ggcgatgttg 60
aatcctctcg tgggtgttgc aatcctcttg gcataaaggt gagcgacaaa atgaacccca 120
gtgacttggt gaagctgatt gagattctga acccttcaaa caaacctgga aggatcaccn 180
ataatacaag gactggggca gagaacanta gagtgtaa 218

<210> 14
<211> 227
<212> DNA
<213> Zea mays

<400> 14

acatgttgtg ggttggtgag cgactcgac aactcgatgg agtcatgtt gaattcctcc 60
gtggtgttgc caaccctctg ggcataaagg tgagcgacaa aatgaacccc agtgagttgg 120
tgaagctgat tgatattctg aacccttcaa acaaacctgg aaggatcacc ataattacaa 180
ggatgggggc agagaacatg aggggtgaagt tgcctcatct catccgt 227

<210> 15
 <211> 267
 <212> DNA
 <213> Zea mays

 <400> 15

 cgcaacgagtg ccttctctta ccctacgagc agtctcttac ccgtaaagac tccaccagtg 60
 gcctttttcta cgattgttct gccacatgt tgtgggatgt agagcgcaact cgtaaacctcg 120
 atgtagcgca tgttgaattc cttcgtggtg ttgccaatcc tcttggcata aaggtagagcg 180
 acaaaatgaa ccccgatgac ttggtgaagc tgattgagat tctgaaccct tcaaacaaac 240
 ctggaaggat caccataatt acaagga 267

<210> 16
 <211> 309
 <212> DNA
 <213> Zea mays

 <400> 16

 aaattggccc ataggggtgga tgaggctctt gggttcatga ctgcagcagg gcttacagtt 60
 gaccacccga taatgacgac tactgacttc tggacctcgc acgagtgcct tctcttacct 120
 tacgagcagt ctcttacctg taaagactcc accagtggcc ttttctacga ttgttcggcc 180
 cacatgttgt gggttggtga ggcactcgt caactcgatg gagcgcatgt tgaattcctc 240
 cgtggtgttg ccaaccctct tggcataaag gcgagcgaca aaatgaaccc cagtgaattg 300
 gtgaagctg 309

<210> 17
 <211> 296
 <212> DNA
 <213> Zea mays

 <400> 17

 cccacgcgtc cgatgggggc agagaacatg aggggtgaagt tgccatcatc catccgtgct 60
 gttcgcaatg ctggactgat tgtcacatgg attactgatc ctatgcatgg aaacaccatc 120
 aaggcccctt gtggcctgaa gactcgtcca tttgactcca ttctggetga agtgcggtgcc 180
 ttcttcgatg tgcattacca agaaggaagc caccctgggg gcgtccacct tgaaatgact 240
 gggcagaacg tgaccgagt catcggtgga tcacggaccg tgaccttcga cgatct 296

<210> 18
 <211> 272
 <212> DNA
 <213> Zea mays

 <400> 18

 ggaaacacca tcaaggcccc ttgtggcctg aagactcgtc cattcgactc aattotggct 60
 gaagtgcgcg cattotttoga cgtgcatgat caagaaggaa gtcacccagg aggcattccac 120
 cttgaaatga ctgggcagaa cgtgaccgag tgcattgggtg gatcacggac tgtgaccttc 180
 gatgacctta gtgaccgcta ccacaccacac tgtgacccaa ggctgaacgc ctcccagttcc 240
 ctggagctcg ccttcatcat tgcagagagg ct 272

<210> 19
 <211> 328
 <212> DNA
 <213> Zea mays

 <400> 19

 gcgtcactca gtggaacctc gatttcatgg atcacaacga gcaaggatgat aggtaccgtg 60
 aataggccca taggggtggat gatgctcttg ggttcatgac tgcacgaggc cttacagtgc 120
 accaccgat aatgacgact actgacttct ggacctcgca cgagtgcctt ctcttaccct 180
 acgagcaggc tcttaccgtg gaggattcca ccagtggcct tttctatgat tgttcggccc 240
 acatgtttgtg ggttgggtgag cgcactcgac aactcgatgg agctcatggt gaattcctcc 300
 gtggtgttgc caaccctctg ggcataaa 328

<210> 20
 <211> 265
 <212> DNA
 <213> Zea mays

 <400> 20

 gggttcatga ctgcagcagg gcttacagtt gaccacccga taatgacgac tactgacttc 60
 tggacctcgc acgagtgcct tctcttaccg tacgagcagt ctcttaccgc taaagactcc 120
 accagtggcc ttttctacga ttgttcggcc cacatgttgtt gggttgggtga gcgcactcgt 180
 caactcgatg gagcgcatgt tgaattcttc cgttgtgttg ccaaccctct tggcataaag 240

gtgagcgaca aaatgaaccc cagtg

265

<210> 21
<211> 232
<212> DNA
<213> Zea mays

<400> 21

cccacgcgtc cggacgacta ctgacttctg gacctcgcac gagtgccttc tcttacccta 60
cgagcagtct cttaccogta aagactccac cagtggcctt ttctacgatt gttcggccca 120
catgttgttg gttggtgagc gcaactcgtca actcgatgga gcgcatgttg aattcctccg 180
tgggtgttgcc aacctctctg gcataaaggt gagcgacaaa atgaacccca gt 232

<210> 22
<211> 320
<212> DNA
<213> Zea mays

<400> 22

agcaagggtga taggtaccgt gaattggccc ataggggtgga tgatgctctt gggttcatga 60
ctgcacgagg gcttacagtc gaccacccga taatgacgac tactgacttc tggacctcgc 120
acgagtgcct tctcttacc ctagagcagg ctcttaccg tgaggattcc accagtggcc 180
ttttctatga ttgttcggcc cacatgttgt gggttggtga gcgcactcga caactcgatg 240
gagctcatgt tgaattcctc cgtggtgttg ccaacctct gggcataaag gtgagcgaca 300
aaatgaaccc cagtgagttg 320

<210> 23
<211> 309
<212> DNA
<213> Zea mays

<400> 23

tgcaatttgt ggaatttagg tgagcgacaa aatgaacccc agtgagttgg tgaagctgat 60
tgatattctg aacccttcaa acaaacctgg aaggatcacc ataattacaa ggatgggggc 120
agagaacatg aggggtgaagt tgcctcatct catccgtgct gttcgcaatg ctggactgat 180
tgtcacatgg attactgatc ctatgcatgg aaacaccatc aaggccctt gtggcctgaa 240

gactcgtcca ttgactcca ttctggctga agtgcgtgcc ttcttcgatg tgcatgacca 300
agaaggaag 309

<210> 24
<211> 336
<212> DNA
<213> Zea mays

<400> 24

gtgctgttcg caatgctgga ttaattgtca catgattact gatcctatgc atggatacac 60
catcaaggcc ccttgtggtc tgaagactcg tccattcgac tcaattcttg ctgaagtgcg 120
cgcattotc gacgtgcatg atcaagaagg aagtcaccca ggaggcatcc accttgaaat 180
gactgggcag aacgtgaccg agtgcattgg tggatcacgg actgtgacct tcgatgacct 240
tagtgaccgc taccacaccc actgtgaccc aatgctgaac gcctcccagt ccctggagct 300
cgcccttcac attgcagaga gtcaggaaga ggaggt 336

<210> 25
<211> 303
<212> DNA
<213> Zea mays

<400> 25

agcgagcaag gtgataggta ccgtgaattg gcccataggg tggatgaggc tottgggttc 60
atgactgcag cagggcttac agttgaccac ccgataatga cgactactga cttctggacc 120
tcgcacgagt gccttctctt accctacgag cagtctctta ccgtaaaga ctccaccagt 180
ggccttttct acgattgttc ggccacatg ttgtgggttg gtgagcgcac tcgtcaactc 240
gatggagcgc atgttgaatt ccttcgtggt gttgccaatc ctcttggcat aaaggtgagc 300
gac 303

<210> 26
<211> 248
<212> DNA
<213> Zea mays

<400> 26

gacaaaatga accccagtga gttggtgaag ctgattgata ttctgaaccc ttcaaacaaa 60

cctggaagga tcaccataat tacaaggatg ggggcagaga acatgagggt gaagttgcct 120
catctcatcc gtgctgttcg caatgctgga ctgattgtca catggattac tgatcctatg 180
catggaaaca ccatcaaggc cccttgtggc ctgaagactc gtccatttga ctccattctg 240
gctgaagt 248

<210> 27
<211> 262
<212> DNA
<213> Zea mays
<400> 27

ggatcaccat aattacaagg atgggggcag agaacatgag ggtgaagttg cctcatctca 60
tcogtgcgtg tcgcaatgct ggactgattg tcacatggat tactgatcct atgcatggaa 120
acaccatcaa ggccccttgt ggccctgaaga ctcgctccatt tgactccatt ctggctgaag 180
tgcgctgcctt cttcgatgtg catgaccaag aaggaagcca ccctgggggc gtccaccttg 240
aatgactgg gcagaacgtg ac 262

<210> 28
<211> 291
<212> DNA
<213> Zea mays
<400> 28

tgagcgacaa aatgaacccc agtgactttg tgaagctgaa tgagattctg aaccottcaa 60
acaaacctgg aaggatcacc ataattacaa ggatgggggc agagaacatg agagtgaagt 120
tgccatcatc catccgtgct gttcgcaatg ctggattaat tgtcacatgg attactgac 180
ctatgcatgg aaacaccatc aaggccctt gtgagctgaa gactcgtcca ttcgactcat 240
tctggctgaa gtgcgcgcat tcttcgacgt gcatgatcaa gaaggaagtc a 291

<210> 29
<211> 313
<212> DNA
<213> Zea mays
<400> 29

ctggccagtt tgccaagcca aggtccgaac cgttggagga gagggacggc gtcaagctgc 60

caagctacag gggcgacaac gtcaacggcg acgacttcac cgagaagagc cgcgtgccag 120
 acccgcacag gatgatccgc gcctactcgc agtcgggtggc gacgctcaac ctgctccgcg 180
 cgttggcgac cggagggtac gctgccatgc agcgcgtcac acagtggaac ctcgatttca 240
 tggatcacag cgagcaaggt gataggtacc gtgaattggc ccatagggtg gatgaggctc 300
 ttgggttcat gac 313

<210> 30
 <211> 305
 <212> DNA
 <213> Zea mays

<400> 30

gcgagcaagg tgataggtac cgtgaattgg cccatagggt ggatgaggct cttgggttca 60
 tgactgcagc agggcttaca gttgaccacc cgataatgac gactactgac ttctggacct 120
 cgcacgagtg ccttctotta ccctacgagc agtctcttac ccgtaaagac tccaccagtg 180
 gccttttcta cgattgttcg gccacatgt tgtgggttgg tgagcgcact cgtcaactcg 240
 atggagcgca tgttgaattc cttcgtggtg ttgccaatcc tcttggcata aagggtgagcg 300
 acaaa 305

<210> 31
 <211> 258
 <212> DNA
 <213> Zea mays

<400> 31

ctggattact gatcctatgc atggaaacac catcaaggcc ccttgtggcc tgaagactcg 60
 tccattcgac tcaattctgg ctgaagtgcg cgcattcttc gacgtgcatg atcaagaagg 120
 aagtcaccca ggaggcatcc accttgacat gactgggcag aacgtgaccg agtgcattgg 180
 tggatcacgg actgtgacct tcgatgacct gagcgaccga taccacaccc actgtgaccc 240
 aaggctgaac gcctccca 258

<210> 32
 <211> 250
 <212> DNA
 <213> Zea mays

<400> 32

gtcgaccacc cgataatgac gactactgac ttctggacct cgcacgagtg ctttctctta 60

ccctacgagc tggctcttac acgtgaggat tccaccagtg gccttttcta tgattgttcg 120

gcccacatgt tgtgggttgg tgagcgcaact cgacaactcg ctcgagctca tgttgaattc 180

ctccgtggtg ttgccaatcc tctgggcata aagggtgagcg acaaaatgaa ccccgatgag 240

ttggtgaagc 250

<210> 33

<211> 290

<212> DNA

<213> Zea mays

<400> 33

catgcagcgc gtcacacagt ggaacctoga tttcatggat cacagcgagc aaggatgatag 60

gtaccgtgaa ttggcccata ggggtgatga ggctcttggg ttcattgactg cagcagggct 120

tacagttgac caccgcgataa tgacgactac tgacttctgg acctcgacg agtgccttct 180

cttaccctac gagcagtcctc ttaccgcgtaa agactccacc agtggccttt tctacgattg 240

ttcggcgcac atgttgtggg ttggtgagcg cactcgtaaa ctgatggag 290

<210> 34

<211> 239

<212> DNA

<213> Zea mays

<400> 34

tgctggatta attgtcacat ggattactga tcctatgcat ggaaacacca tcaaggcccc 60

ttgtggcctg aagactcgtc cattcgactc aattctggct gaagtgcgag cattcttcga 120

cgtgcatgat caagaaggaa gtcacccagg aggcattccac cttgaaatga ctgggcagaa 180

cgtgaccgag tgcattggtg gatcacggac tgtgaccttc gatgacctta gtgaccgct 239

<210> 35

<211> 220

<212> DNA

<213> Zea mays

<400> 35

ggccccttgt ggcctgaaga ctggtccatt cgactcaatt ctggctgaag tgcgcgcatt 60
 cttcgacgtg catgatcaag aaggaagtca cccaggaggc atccaccttg aaatgactgg 120
 gcagaacgtg accgagtgc tgggtggatc acggactgtg accttcgatg accttagcga 180
 ccgctaccac acccactgtg acccaaggct gaacgcctcc 220

<210> 36
 <211> 228
 <212> DNA
 <213> Zea mays

<400> 36

gcacgagtga agactcgtcc atttgactcc attctggctg aagtgcgtgc cttcttcgat 60
 gtgcatgacc aagaaggaag ccaccctggg ggcgtccacc ttgaaatgac tgggcagaat 120
 gtgaccgagt gcatcgggtg atcacggacc gtgaccttcg acgatctgag cgaccgctac 180
 cacaccact gcgacccaag gctgaatgcc tcccagtccc tggagctc 228

<210> 37
 <211> 263
 <212> DNA
 <213> Zea mays

<400> 37

gagttggtga agctgattga tattctgaac ccttcaaaca aacctggaag gatcaccata 60
 attacaagga tgggggcaga gaacatgagg gtgaagttgc ctcatctcat ccgtgctggt 120
 cgcaatgctg gactgattgt cacatggatt actgatccta tgcattgaaa caccatcaag 180
 gccccttgtg gcctgaagac tcgtccattt gactccattc tggctgaagt gcgtgccttc 240
 ttcgatgtgc atgaccaaga agg 263

<210> 38
 <211> 241
 <212> DNA
 <213> Zea mays

<400> 38

cgatttcatt gatcacaacg agcaaggatg taggtaccgt gaattggccc atagggtgga 60
 tgatgctctt gggttcattg ctgcatggg gcttacagtc gaccaccga taatgacgac 120

tactgacttc tggacctcgc acgagtgcct tctcttacct tacgagcagg ctcttacctg 180
 tgaggattcc accagtggcc ttttctatga ttgttcggcc cacatgttgt gggttggtga 240
 g 241

<210> 39
 <211> 225
 <212> DNA
 <213> Zea mays

<400> 39

aaacaaacct ggaaggatca ccataattac aaggatgggg gcagagaaca tgagggtgaa 60
 gttgcctcat ctcatccgtg ctgttcgcaa tgctggactg attgtcacat ggattactga 120
 tcctatgcat ggaaacacca tcaaggcccc ttgtggcctg aagactcgtc catttgactc 180
 cattctggct gaagtgcgtg ccttcttcga tgtgcatgac caaga 225

<210> 40
 <211> 248
 <212> DNA
 <213> Zea mays

<400> 40

atcgaccacc cgataatgac gactactgac ttctggacct cgacagagtg ccttctctta 60
 ccctacgagc aggtctcttac ccgtgaggat tccaccagtg gccttttcta tgattgttcg 120
 gtccacatgt tgtgggttgg tgagcgcaact cgacaactcg atggagctca tgttgaatac 180
 ctccgtggtg ttgccaacct tctgggcata aagggtgagcg acaaaatgca cccagtgag 240
 ttggtgaa 248

<210> 41
 <211> 227
 <212> DNA
 <213> Zea mays

<400> 41

tcttgggttc atgactgcag cagggtcttac agttgaccac ccgataatga cgactactga 60
 cttctggacc tcgcacgagt gccttctctt accctacgag cagtctctta cccgtaaaga 120
 ctccaccagt ggctttttct acgattgttc ggcccacatg ttgtgggttg gtgagcgcac 180

tcgtcaactc gatggagcgc atgttgaatt ccttcgtggt gttgccca 227

<210> 42
<211> 170
<212> DNA
<213> Zea mays

<400> 42

agctgattga gattctgaac ccttcaaaca aacctggaag gatcaccata attacaagga 60

tgggggcaga gaacatgaga gtgaagttgc ctcatctcat cegtgtgtgt cgcaatgctg 120

gattgattgt cacatggatt actgatccta tgcattggaaa caccatcaag 170

<210> 43
<211> 277
<212> DNA
<213> Zea mays

<400> 43

gcgcgcattc ttcgacgtgc atgatcaaga aggaagtcaac ccaggaggca tccaccttga 60

aatgactggg cagaacgtga ccgagtgcac tgggtggatca cggactgtga ccttcgatga 120

cctgatcgac cgtaccaca cccacgtgac ccaaggotga acgcctccca gtccctggag 180

ctcgcttca tcattgcaga gaggtcagg aagaggagga tgcggtcggg gctcaacaac 240

agcctgcctc tgccaccact ggctttctaa gtagccg 277

<210> 44
<211> 281
<212> DNA
<213> Zea mays

<400> 44

ccaagaatga accaccctgg gggcgtccac cttgaaatga ctgggcagaa cgtgaccgag 60

tgcattcgtg gatcacggac cgtgaccttc gacgatctga ggcaccgcta ccacaccac 120

tgcgacccaa ggctgaatgc ctcccagtcc ctggagctcg cctttatcat cgcagagagg 180

ctgaggaaga ggaggatgcg atcggggctc aacagcagcc tgccactgcc gccactggct 240

ttctgagtag ccggagccaa acacaaagga gggtaggaat a 281

<210> 45
 <211> 273
 <212> DNA
 <213> Zea mays

 <400> 45

 ggctacttag aaagccagtg gtggcagagg caggctgttg ttgagccccg accgcatcct 60
 cctcttcctg agcctctctg caatgatgaa ggcgagctcc agggactggg aggcgttcag 120
 ccttgggtca cagtgggtgt ggtagcggtc gctcagggtca tcgaagggtta cagtccgtga 180
 tctaccaatg cactcgggtca cgttctgccc agtcatttca aggtggatgc ctctgggtg 240
 atttccttct tgatcatgca cgtcgaagaa tgc 273

<210> 46
 <211> 201
 <212> DNA
 <213> Zea mays

 <400> 46

 ggcccccttgt ggccctgaaga ctcgctccatt tgactccatt ctggctgaag tgcgtgcctt 60
 cttcgatgtg catgaccaag aaggaagcca cctggggggc gtccaccttg aaatgactgg 120
 gcagaacgtg accgagtgc tgggtggatc acggaccgtg accttcgacg atctgagcga 180
 ccgctaccac acccaactgcg a 201

<210> 47
 <211> 228
 <212> DNA
 <213> Zea mays

 <400> 47

 ccacgcgtcc ggtgaagttg cctcatctca tccgtgctgt tcgcaatgct ggattaattg 60
 tcacatggat tactgatcct atgcatggaa acaccatcaa ggcccccttgt ggccctgaaga 120
 ctcgctccatt cgactcaatt ctggctgaag tgcgcgcatt cttcgacgtg catgatcaag 180
 aaggaagtca ccaggaggc atccaccttg aaatgactgg gcagaacg 228

<210> 48
 <211> 301
 <212> DNA
 <213> Zea mays

<400> 48

cgtgaattgg cccatagggg ggatgatgct cttgggggtca tgactgcac ggggcttaca 60

gtcgaccacc cgataatgac gactactgac ttctggacct cgaacgaggt gccttcgctt 120

accctacgag caggctotta cccgtgagga ttccaccagt ggccttttct atgattgtta 180

cgcccacatg ttgtgggttg gtgagcgac tcgacaactc gatggagctc atgttgaatt 240

cctccgtggt gttgcccaacc ctctgggcat aaaggtgagc gacaaaatga accccagtga 300

g 301

<210> 49

<211> 332

<212> DNA

<213> Zea mays

<400> 49

gccaccctgg gggcgtccac cttgaaatga ctgggcagac gtgaccgagt gcatcggtgg 60

atcacggacc gtgacctcg acgatctgag cgaccgctac cacaccact gcgacccaag 120

gctgaatgcc tccagttccc tggagctcgc ctttatcacc gcagagaggc tgaggaagag 180

gaggatgcga tcgggggtca acagcagcct gccactgcgc cactggctt tctgagtagc 240

cggagccaaa cacaaggag ggtaggaata gctgtggtga ctcggaagag aaagagacag 300

tcgacgcctt gttttgttga tgctagtgtg gt 332

<210> 50

<211> 310

<212> DNA

<213> Zea mays

<223> unsure at all n locations

<400> 50

cgacgacttc accgagaaga gccgcgtgcc ggaccgcag aggatgatcc ggcctacgc 60

acagtcggtg gcgacactca acctgctccg cgcgttcgcc accggagggt acgctgcat 120

gcacgcgtca ctcaagtggaa cctcgatttc atggatcaca acgagcaagg tgataggtac 180

cgtgaattgg cccatagggg ggatgatgct cttgggttca tgactgcac ggggcttaca 240

gtcgaccacc cgataatgac gactactgac ttctggacct cgcacgagtg ctttctctt 300

acctacgagc

310

<210> 51
<211> 227
<212> DNA
<213> Zea mays

<400> 51

cgacgacttc accgagaaga gccgcgtgcc agaccgcagc aggatgatcc gcgcctactc 60
gcagtcggtg gcgacgctca acctgctccg cgcgttggcg accggagggc acgctgccat 120
gcacgcgtca cacagtggaa cctcgatttc atggatcaca gcgagcaagg tgataggtac 180
cgtgaattgg cccatagggc ggatgaggtc cttgggttca tgactgc 227

<210> 52
<211> 215
<212> DNA
<213> Zea mays

<400> 52

aggcttacag ttgaacaccc gataatgacg actactgaat tctggacctc acacgagtgc 60
cttctcatac actaagaaaa gtctcttacc cgtaaagaat ccaccagtgg ctttttctac 120
gattgttcgg cccacatgct gtgggttggc gagcgcaact gtcaactcga tggagcgcat 180
gtatgaattc cttcgtggtg ttgcaatcct cttgg 215

<210> 53
<211> 249
<212> DNA
<213> Zea mays

<400> 53

gagaagagcc gcgtgccgga cccgcagagg atgatccgcg cctacgcaca gtcggtggcg 60
acactcaacc tgctccgcgc gttcgcacc ggagggtacg ctgccatgca cgcgtcactc 120
agtggaacct cgatttcatt gatcacaacg agcaagggtga taggtaccgt gaattggccc 180
atagggtgga tgatgctctt gggttcatga ctgcatcggg gcttacagtc gaccaccgca 240
taatgacga 249

<210> 54

<211> 184
 <212> DNA
 <213> Zea mays

<400> 54

ctccatcgag ttgacgagtg cgctcaccaa ccacaaacat gtgggcccga caatcgtaga 60
 aaaggccact ggtggagtct ttacgggtaa gagactgctc gtagggtaag agaaggcact 120
 cgtgcgaggt ccagaagtca gtagtcgtca ttatcgggtg gtcaactgta agcctgctg 180
 cagt 184

<210> 55
 <211> 202
 <212> DNA
 <213> Zea mays

<400> 55

gaagttgcct catctcatcc gtgctgttcg caatgctgga ttaattgtca catggattac 60
 tgatcctatg catggaaaca ccatcaaggc cccttgtggc ctgaagactc gtccattcga 120
 ctcaattctg gctgaagtgc ggcattctt cgacgtgcat gatcaagaag gaagtcaccc 180
 aggaggcatc caccttgaaa tg 202

<210> 56
 <211> 279
 <212> DNA
 <213> Zea mays

<400> 56

cggctcgagg ccaccctggg ggcgtccacc ttgaaatgac tgggcagaat gtgaccgaga 60
 ccatcggtgg atcacggacc gtgaccttcg acgatctgag cgaccgctac cacaccact 120
 gcgacccaag gctgaatgcc tcccagtccc tggagctcgc ctttatcadc gcagagagggc 180
 tgaggaagag gaggatgcga tcggggctca acagcagcct gccactgccg cactgggctt 240
 tctgagtagc cggagccaaa cacaaggag ggtaggaat 279

<210> 57
 <211> 205
 <212> DNA
 <213> Zea mays

<400> 57

tctgaaccgt tggaggagag ggacggcgtc aagctgccaa gctacagggg cgacaacgtc 60

aacggcgacg acttcaccga gaagagccgc gtgccagacc cgcagaggat gatccgcgcc 120

tactcgcagt cgggtggcgac gctcaacctg ctccgcgcgt tggcgaccgg aggggtacgt 180

gccatgcagc gcgtcacaca gtgga 205

<210> 58

<211> 124

<212> DNA

<213> Zea mays

<400> 58

tgtgctgttc gcaatgctgg attaattgtc acatggatta ctgacacctat gcatggaaac 60

accatcaagg ccccttgtgg cctgaagact cgtccattcg actcaattct ggctgaagtg 120

cgcg 124

<210> 59

<211> 272

<212> DNA

<213> Zea mays

<400> 59

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cgaaaacagg gctgggagaa taaccatcat cacaagaatg ggacctgaaa acatgaggggt 120

gaaacttcca cacctgatac gcgctgtccg tggggccggc cagatagtaa catggggttac 180

tgacccaatg catgggaaca ctatgaaggc cccttgcgga ctcaaaaccc gtcggttcga 240

caggattttg ggtgaggtgc gtgcgttctt tg 272

<210> 60

<211> 237

<212> DNA

<213> Zea mays

<400> 60

tggacacggt gctcaaaacc atcgagacgt tcccgcgggt ggtgttcgcc ggagaggcgc 60

gccacctcga ggagcgcgat gccgaggccg ccatggggccg cgccttcac ctcaggggcg 120

gcgactgcgc cgagagcttc aaggagttcc acgccaacaa catccgtgac accttccgta 180
 tcctgctgca gatgggcgcc gtgctcatgt tcgggtgtca ggtgccggtc gtcaagg 237

<210> 61
 <211> 215
 <212> DNA
 <213> Zea mays
 <400> 61

accaggagga gctggacacg gtgctcaaaa ccatcgagac gttcccgcgc gtggtgttcg 60
 ccggagaggg gcgccacctc gaggagcgca tggccgaggg ccgatgggc cgcgccttca 120
 tcctccaggg cggcgactgc gccgagagct tcaaggagta ccacgccaac aacatccatg 180
 acaccttccg tatcctgctg cagatggggc ccgtg 215

<210> 62
 <211> 125
 <212> DNA
 <213> Zea mays
 <400> 62

tggacacggt gctcaagatc atcgagacgt tcccgccggg ggtgttcgcc ggagaagcgc 60
 gtcacctcga ggagcgcatg gccgaagccg ccattggccg cgccttcac ctcctgacg 120
 gcgac 125

<210> 63
 <211> 287
 <212> DNA
 <213> Zea mays
 <400> 63

gtgctgcgga cgggtgggaac gttcccgcgc atcgttctcg cgggcgaggg gcgcaccctc 60
 gaggagcgcc tcgcggaggg ccgcgtcgcc cgggccttcc tcctccaggg cggcgactgc 120
 gccgagagct tcaaggagtt caacgccaac aacatcaggg acaccttccg cgtcctcatg 180
 caaatgtccg ttgtgctcat gttcggaggg cagatgcctg tcgtcaaggt gggaagaatg 240
 gcaggtcagt ttgcgaagca aggtcagatg gttttgagga gcgggat 287

<210> 64

<211> 305
 <212> DNA
 <213> Zea mays

 <400> 64

 cccacgcgtc cgcccaacgcg tccggtcagc tgctgggctc cctttagatc accctataat 60
 gacaacagca gaattttgga cgtcacatga gtgtcttctt ctaccttatg agcaagcgtc 120
 cactcgtgag gattccacca cgggcctcta ttatgactgc tctgccact tcctatgggt 180
 cggagagcgc actcgccagc ttgatgggtgc tcacgttgag ttccttcgag gcattgccaa 240
 ccctcttgggt atcaagggtta gtgacaagat ggaccagca gaacttgtgc ggttgattga 300
 tatat 305

<210> 65
 <211> 311
 <212> DNA
 <213> Zea mays

 <400> 65

 ggccgcgcct tcattcctcca gggcggcgac tgccgcgaga gcttcaagga gttccacgcc 60
 aacaacatcc gtgacacctt ccgtattctg cttcagatgg gcgccgtgct catgttcggt 120
 ggtcaggtgc cggtcgtcaa cgtggggagg atggctggcc agtttgccaa gccaaggtcc 180
 gaaccgttgg aggagagggg cggcgtcaag ctgccaaagt acaggggcca caacgtcaac 240
 ggcgacgact tcaccgagaa gagccgcgtg ccagaccgcg agaggatgat ccgcgcctac 300
 tcgcagtcgg t 311

<210> 66
 <211> 271
 <212> DNA
 <213> Zea mays

 <400> 66

 gcgccgagag tttcaaggag ttccacgcc acaacatccg tgacaccttc cgcgtccttc 60
 tccagatggg cgtcgtgctc atgttcggtg gccagatgcc ggtcgtcaag gtggggagga 120
 tggctggcca gttcgccaag ccaaggtctg agccgttcga ggagaaggac ggagttaagc 180
 tgccgagctc caggggagc aacgtcaacg gcgacgactt caccgagaag agccgcgtgc 240

cggacccgca gaggatgatc cgcgcctacg c

271

<210> 67
<211> 264
<212> DNA
<213> Zea mays

<400> 67

cacgccaaca acatccgtga caccttccgt attctgcttc agatgggccc cgtgctcatg 60
ttcgggtggtc aggtgccggt cgtcaagggt gggaggatgg ctggccagtt tgccaagcca 120
aggtccgaac cgttggagga gagggaacgg gtcaagctgc caagctacag gggcgacaac 180
gtcaacggcg acgacttcac cgagaagagc cgcgtgccag accgcagag gatgatccgc 240
gcctactcgc agtcgggtggc gacg 264

<210> 68
<211> 265
<212> DNA
<213> Zea mays

<400> 68

cccacgcgtc cgagatgggc gtcgtgctca tggtcgggtg ccagatgccg gtcgtcaagg 60
tggggaggat ggctggccag ttcgccaagc caagggtctga gccgttcgag gagaaggacg 120
gagttaagct gccgagctac aggggcgaca acgtcaacgg cgacgacttc accgagaaga 180
gccgcgtgcc ggacccgcag aggatgatcc gcgcctacgc acagtcggtg gcgacactca 240
acctgctccg cgcgttcgcc accgg 265

<210> 69
<211> 315
<212> DNA
<213> Zea mays

<400> 69

caaggagttc cacgccaaca acatccgtga caccttccgc gtccttctcc agatgggccc 60
cgtgctcatg ttcgggtggca agatgccggt cgtcaagggt gggaggatgg ctggccagtt 120
cgccaagcca aggtctgagc cgttcgagga gaaggacgga gttaagctgc cgagctacag 180
gggcgacaac gtcaacggcg acgacttcac cgagaagagc cgcgtgccgg accgcagag 240

gatgatccgc gcctacgcac agtcggtggc gacactcaac ctgctccgcg cgttcgccac 300
cggagggtac gctgc 315

<210> 70
<211> 286
<212> DNA
<213> Zea mays

<400> 70

gacccgagag tttcaaggag ttccacgcc acaacatccg ggagcccttc cgcgtcgttc 60
tccagatggg cgtcgtgctc atgttcggtg gccagatgcc ggtcgtcaag gtggggagga 120
tggctggcca gttcgccaag ccaaggctct agccgttcga ggagaaggac ggagttaagc 180
tgccgagcta caggggacgac aacgtcaacg ggcagcactt caccgagaag agccgcgtgc 240
cggacccgca gaggatgatc cgcgcctaca gcacatcggg ggcgac 286

<210> 71
<211> 284
<212> DNA
<213> Zea mays

<400> 71

catgacctta gtgaccgcta ccacaccac tgtgacccaa ggctgaacgc ctcccagttc 60
ctggagctcg ccttcatcat tgcagagagg ctccaggaaga ggaggatgcg gtcggggctc 120
aacaacagcc tgcctctgcc accactggct ttctaagtag ccgaagctga acagagaagg 180
tagaggggat agttgcggcg actcgaaaaga ttacgcctgt ttatttggtg atgcttggtg 240
tggaggcctg gtgggtgctc ttggcacaag ttacatgctg ggga 284

<210> 72
<211> 390
<212> DNA
<213> Zea mays

<400> 72

accacgcgt ccgcccggcg ctccctttgc cgtggtgggg gcgggcccgc cgcggtgcgc 60
tcgtccgcgc ccgcgccgcg gccgtccgcg cggcgctacg gcccccgagc cagtgggtccg 120
tcgggagctg gcggggccgc ccggcgcagc agcagccga gtacccggac aaggcggacc 180

tggaagacgt gctgcggacg gtgggaacgt tcccgcccat cgtcttcgcc ggcgaggcgc	240
gcaccctcga ggagcgccctc ggcgaggccg ccgtcggccg ggccttcctc ctccagggcg	300
gcgactgcgc cgagagcttc aaggagttca acgccaacaa catcagggac accttccgcg	360
tcctcctgca aatgtccgtt gtgctcatgt	390

<210> 73
 <211> 322
 <212> DNA
 <213> Zea mays

<223> unsure at all n locations
 <400> 73

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atgcccgcga ttatacatat attttttttt ccctccaatt catgaatcca tctggaggac	120
attttaaagc ctgtcataca ataatctatt tctatacctc acataattac cttctcctac	180
cttactagca atccttaacc cttcaagact ccaccacga tcttttctac tactgctcct	240
tccacatgct ctcatcgcac gagctcacco tgcaacttga taacctccat ctacagttcc	300
tgatggagat cgccaacccc ct	322

<210> 74
 <211> 439
 <212> DNA
 <213> Zea mays

<400> 74

gcatgactga gtttgtaggt accgtgaatt ggcacatcgg gttgatgatg cccttggatt	60
catgggtgca actgggctga caatggacca gcctttgacg acgatgatcg agtttctgga	120
cctaacaatga gtgcttcctc ctaccttaca agcaagcctt aaccggcag gattccacca	180
ccggcctttc tataaatggt tcggccacat actcttggtt cggagagcga caccgaact	240
tgaatggccc atatgtagag tctctgaggg agatcgcaaa ccctcttggt atcaaggtga	300
gccacaatat ggagcccgga gagctggaaa atctgatoga catactgaac ccgacgaaca	360
agcccgagag gatcacgctc atcacagga tgggcgcaga gcacatcagg gtcaagttac	420
ctcaccttat ccgcgcggt	439

<210> 75
 <211> 434
 <212> DNA
 <213> Zea mays

 <400> 75

 cccacacatc cacatttcca ataacacatt tcatcgcaac atataccatc cttcactggt 60
 ggcatcatga acacatgtgg gtgaaactta cacacctgat acccgctgtc cattctgccc 120
 gtcagatagt aacatggggt actgacccaa tgcattggaa cactattaag gccattgcg 180
 gactcaaaac cctctcggtc gacaggatct tgggtcacgt gcggtcggtc tttgatgtcc 240
 acgaacaaga agggagccac cctggaggag tgcattctga gatgactgga caaaatgtta 300
 cacagtgcac cggcggttca cgtactgtta ccttcgatga tctgggggtc cgctaccaca 360
 cgcactgcta cccaaggctc aatgccttac agtctctgga gattgcattt atcatcgccg 420
 aacgccttat gaaa 434

<210> 76
 <211> 437
 <212> DNA
 <213> Zea mays

 <400> 76

 cggacgcgtg ggcgagcaag ccttaacccg gcaagactcc accaccggtc ttttctacga 60
 ctgctccgcc cacatgtctt gggtcggcga gcgcacccgg cagcttgatg gcgtccatgt 120
 ggagttcctg aggggggatc ccaacccctc tggcatcaag gtgagcgaca agatggagcc 180
 cggcgagctg gtgaagctga tcgacatact gaacccgacg aacaagcccg ggaggatcac 240
 cgtcatcaca aggatggggg cagagaacat cagggtcaag ttacctcacc ttatccgcgc 300
 ggtccgccag gctggacaga gtgtcacctg gatcactgac cggatgcacg ggaacaccat 360
 caagactcct tgcggacgaa agactcggcc atttgactcc attctggccg aggtacgggc 420
 cttcttcgac gtgcacg 437

<210> 77
 <211> 347
 <212> DNA
 <213> Zea mays

 <400> 77

ggcacgccta cgcttccgcc tacgcgttgt ctgactcgtg ggctttcgcg tggtcggacg 60
 cgtggggccga cgctgggtgcc gtagaagaag ccggtagcgc acgggaagtg tgcggctctac 120
 agctggaggt ccaagaaggc tttgcagctc cccgagtacc cgaacgcgga tgagctggac 180
 gctgtgctga agaccatcga gacgttcccg ccggtggtgt tcgtcggaga ggctcgccgt 240
 ctcgaggagc gcatggccga ggccggcatg ggccgcgcct tcgtcctcca aggtggcgac 300
 tgctccgaga gtttcaagga gttccacgcc aacaacatgc gtgacac 347

<210> 78
 <211> 258
 <212> DNA
 <213> Zea mays

<400> 78

tcgcccacgc gtacgcccac gcgtacgcc acgcgtccgt ccacgcgtcc ggcaaggatga 60
 taagtaccgg gaattggccc atacggtgga tgatgctctt gggttcatga ctgcatcggg 120
 gcttacaggc gaacaaccgg ttatgaccac tactgacttc tggaccttgg accaatggct 180
 tttcttacc tacgagcagg ctcttaccgg tgaggattcc accagtggcc ttttctatga 240
 atggtcgggc cacaatgt 258

<210> 79
 <211> 448
 <212> DNA
 <213> Zea mays

<400> 79

acgctgactt ctggacctcg cacgagtgcc gtctcttacc ctacgagcag gctcttgccc 60
 gtggggattc caccaggggc cttttctatg attgttcggc ccacatgttg tgggttggtg 120
 agcgcactcg acaactcgat ggagctcatg ttgaattcct ccgtggtgtt gccaaccccta 180
 tgggcataaa ggtgagcgac aaaatgaacc ccagtgaagt ggtgaagctg attgatattc 240
 tgaacccttc aaacaaacct ggaaggatca ccataattac aaggatgggg gcagagaaca 300
 tgagggtgaa gttgcctcat ctcatccgtg ctgttcgcaa tgctggactg attgtcacat 360
 ggattactga tcctatgcat ggaaacacca tcaaggcccc ttgtggcctg aagactcgtc 420
 catttgactc cattctggct gaagtgcg 448

<210> 80
 <211> 459
 <212> DNA
 <213> Zea mays

<223> unsure at all n locations
 <400> 80

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 ctagttgnaa tcctccgtgg tgttgccaac cctctgggca taaaggtgag tcgacaacaa 120
 tgaatcccca gtgagttggg gaagctgatt gatattctga acccttcaaa caaacctgga 180
 aggatcacca taattacaag gatgggggca gagaacatga ggggtgaagtt gcctcatctc 240
 atccgtgctg ttcgcaatgc tggactgatt gtcacatgga ttactgatcc tatgcatgga 300
 aacaccatca aggccccttg tggcctgaag actcgccat ttgactccat tctggctgaa 360
 gtgctgcct tcttcgatgt gcatgaccaa gaatgaagcc accctggggg cgtccacctt 420
 gaaatgactg ggcagaacgt gaccgagtgc atcgggtgga 459

<210> 81
 <211> 369
 <212> DNA
 <213> Zea mays

<223> unsure at all n locations
 <400> 81

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 ggtggtgtgg ccaatcctct tggcataaag gtgagcgaca aaatgaaccc cagtgacttg 120
 gtgaagctga ttgagattct gaacccttca aacaaacctg gaaggatcac cataattaca 180
 aggatggggg cagagaacat gagagtgaag ttgcctcatc ttatccgtgc tgttcgcaat 240
 gctggattaa ttgtcacatg gattactgat cctatgcatg gaaacaccat caaggcccct 300
 tgtggccctg agactcgtnc atttgactca attctggctg aagtgcgcgc attcttcgat 360
 gtgcatgat 369

<210> 82
 <211> 455
 <212> DNA
 <213> Zea mays

<400> 82

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atgcagtctc acaaccgtgc tgttcgcaat gctggactga ttgtcacatg gattactgat 120

cctatgcatg gaaacaccat caaggccoct tgtggcctga agactcgtcc atttgactcc 180

attctggctg aagtgcgtgc cttcttcgat gtgcatgacc aagaaggaag ccaccctggg 240

ggcgtccacc ttgaaatgac tgggcagaac gtgaccgagt gcatcgggtg atcacggacc 300

gtgaccttcg acgatctgag cgaccgctac cacaccact gcgaccaag gctgaatgcc 360

tcccagtcctc tggagctcgc ctttatcctc gcagagagggc tgaggaagag gacgatgcga 420

tcgggggtca acagcagcct gccactgccg ccaact 455

<210> 83

<211> 405

<212> DNA

<213> Zea mays

<400> 83

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gtaccgtgaa ttggcccata ggggtggatga tgcctttggg ttcattgactg catcgggggt 120

tacagtgcac caccgcgataa tgacgactac tgactttctg acctcgcacg agtgccttct 180

cttaccctac gagcaggtctc ttaccgtgga ggattccacc agtggccttt tctatgattg 240

ttcggcccac atgttgtggg ttggtgagcg cactcgacaa ctcgatggag ctcatgttga 300

attcctccgt ggtgttgcca accctctggg cataaagggtg agcgacaaaa tgaacccag 360

tgagttgggtg aagctgattg atattctgaa cccttcaaac aaacc 405

<210> 84

<211> 444

<212> DNA

<213> Zea mays

<400> 84

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gtccggggcgt tcgccaccgg agggtagct gccatgcage gcgtcactca gtggaacctc 120

gatttcattg atcacaacga gcaaggatgat aggtaccgtg aattggccca taggggtggat 180

gatgctcttg gggtcatgac tgcacggggg cttacagtcg accacccgat aatgacgact 240
actgacttct ggacctcgca cgagtgcctt ctcttaccct acgagcaggc tcttaccctg 300
gaggattcca ccagtggcct tttctatgat tgttcggccc acatgttgtg ggttggtgag 360
cgactcgac aactcgatgg agctcatgtt gaattcctcc gtggtgttgc caaccctctg 420
ggcataaagg tgagcgacaa aatg 444

<210> 85
<211> 371
<212> DNA
<213> Zea mays
<223> unsure at all n locations
<400> 85

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atgagagtga agttgcctca tcttatccgt gctgttcgca atgttggtt aattgtcaca 120
tggattactg atcctatgca tggaaacacc atcaaggccc cttgtggcct gaagactcgt 180
ncatttgact caattctggc tgaagtgcgc gcattcttcg atgtgcatga tcaagaaaga 240
agtcacccca gaggcaccca ccttgaaatg actgngcaga acgtgaccga gtgcattggt 300
ggatcacgga ctgtgacctt cgatgacctg acgaccgcta ccacacccac tgtgacccaa 360
ggctgaacgc c 371

<210> 86
<211> 474
<212> DNA
<213> Zea mays
<400> 86

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acttcacgca gaaaagccgc gtgccggacc cgcagaggat gatccgcgcc tacgcacagt 120
cgggtggcgac actcaacctg ctccgcgcgt tcgccaccgg agggtagcgt gccatgcagc 180
gcgtcactca gtggaacctc gatttcattg atcacaacga gcaaggatgat aggtaccgtg 240
aattggccca taaggatgat gatgctcttg gggtcatgac tgcacggggg cttacagtcg 300
accacccgat aatgacgact actgacttct ggacctcgca cgagtgcctt ctcttaccct 360

acgagcaggc tcttaccctg gaggattcca ccagtggcct tttctatgat tgttcggccc 420
 acatgtttgtg ggttggtgaa gcgaatcgac aactcgatgg acctcatgtt gaat 474

<210> 87
 <211> 423
 <212> DNA
 <213> Zea mays
 <400> 87

gaagactcgt ccatttgact ccattctggc tgaagtgcgt gcctttcttcg atgtgcatga 60
 ccaagaagga agccaccctg ggggcgtcca ccttgaaatg actgggcaga acgtgaccga 120
 gtgcatcggg ggatcacgga ccgtgacott cgacgatctg agcgaccgct accacaccca 180
 ctgcgaccca aggctgaatg cctcccagtc cctggagctc gcctttatca tcgcagagag 240
 gctgaggaag aggaggatgc gatcggggct caacagcagc ctgccactgc cgccactggc 300
 tttctgagta gccggagcca aacacaaaagg agggtaggaa tagctgtggt gactcggaag 360
 agaaagagac agtcgacgcc ttggtttgtt gatgcttagt gtggtgacct ggtggtggtg 420
 gtg 423

<210> 88
 <211> 369
 <212> DNA
 <213> Zea mays
 <223> unsure at all n locations
 <400> 88

ctggctgaag tgcgtgcctt cttcgatgtg catgaccaag aaggaagcca ccttgggggc 60
 gtccaccttg aaatgactgg gcagaacgtg accgagtga tcggtggatc acggaccgtg 120
 accttcgacg atctgagcga ccgtaccac acccactgcy acccaaggct gaatgcctcc 180
 cagtccttgg agctcgccctt tatcatogca gagaggctga ggaagaggag gatgcgatcg 240
 gggctcaaca gcagcctgcc actgccgnca ctggctttct gagtagccgg agccaaacac 300
 aaaggagggt aggaatagct gtggtgacct cggaggagaa gagacagtcg acgccttggt 360
 tggatgatgc 369

<210> 89
 <211> 376

<212> DNA
 <213> Zea mays

 <400> 89

 aattaagctg ccgagctaca ggggcgacaa cgtcaacggc gacgacttca ccgagaagag 60
 ccgcgtgccg gacccgcaga ggatgatccg cgccctacga cagtcgggtg cgacactcaa 120
 cctgctccgc gcgttcgcca ccggagggta cgctgccatg cagcgcgtca ctcaagtggaa 180
 cctcgatttc atggatcaca acgagcaagg tgataggtac cgtgaattgg cccatagggg 240
 ggatgatgct cttgggttca tgactgcacg ggggcttaca gtcgaccacc cgataatgac 300
 aactactgac tttctggact ccgcacaatt gcctccccta acccaacgaa caaggtccta 360
 acccttaagg atccaa 376

<210> 90
 <211> 205
 <212> DNA
 <213> Zea mays

 <400> 90

 gaagttgcct catcttatcc gtgctgttcg caatgctgga ttaattgtca catggatggc 60
 tgatcctatg catggaaaca ccatcaaggc cccttggtggc ctgaagaact gtccatttga 120
 ctcaattctg gctgaagtgc gcgcattctt cgatgtgcat gatcaagaat gaagtcaccc 180
 aggaggcatc caccttgaaa tgact 205

<210> 91
 <211> 391
 <212> DNA
 <213> Zea mays

 <400> 91

 gagtcgtctt gcactgcacg actcctcccc catctaccac tacctgtcta cctaccgagc 60
 ccatcgactg cccctcgcaa cgcaatggcg ctgcgccacca actccgcgcg tgccgcagca 120
 getgccgtat ccggcgggcg ggcattcccag ccgcaccgcg cggccacggt cctcccgctg 180
 aagaggcgca ccatctccgc catccacgcc gccgaccgt ctaagaacaa cgggcccgcg 240
 gtccccgcgg ccgccgcgcg taagtcatct gcctctgcgg tggccacgcc ggagaagaat 300
 ccggcgggcg ccgtaaaagt ggcggtcgac agctggaagt cgaagaaggc actgcagctc 360

ccagagtacc cgaaccagga ggagctggac a

391

<210> 92
<211> 438
<212> DNA
<213> Zea mays

<400> 92

gcggttgatt gatataattga atcccgaaaa cagggctggg agaataacca tcatcacaag 60
aatgggacct gaaaacatga ggggtgaaact tccacacctg atacgcgctg tccgtggggc 120
cggtcagata gtaacatggg ttactgaccc aatgcatggg aacactatga agggcccttg 180
cggactcaaa acccgctcgt tcgacaggat tttgggtgag gtgctgctgt tctttgatgt 240
ccacgaacaa gaagggagcc accctggagg agtgcattta gagatgactg gacaaaatgt 300
tacagagtgc atcggcggtt cacgtacggt gaccttcgat gatctggggg cagctacca 360
cacgcactgc gacccaaggc tcaatgcctc acagtctctg gagatggcat ttatcatcgc 420
cgagcgcctt aagaaaaag 438

<210> 93
<211> 335
<212> DNA
<213> Zea mays

<400> 93

gtgacaagat ggaccagca gaacttgtgc ggttgattga tatattgaat cccgaaaaca 60
gggctgggag aataaccatc atcacaagaa tgggacctga aaacatgagg gtgaaacttc 120
cacacctgat acgcgctgtc cgtggggccg gtcagatagt aacatgggtt actgacccaa 180
tgcattggaa cactatgaag gccccttgcg gactcaaaac ccgctcgttc gataggattt 240
tgggtgaggt gcgtgcgttc tttgatgttc caacggaaaa cccaaaaaaa ggggaaaaaa 300
aagggggggg gggggaaaaa aaggggcccc ccccc 335

<210> 94
<211> 462
<212> DNA
<213> Zea mays

<400> 94

gcggggcgcta cgcgcaactt agctgcagtg cggtcagatt acggggcgagc acgcgtcgag 60
ccggaccgcg tccccccgtc gcccccggcc ccgccccctt cggccccggcc caacggcccc 120
cgaaccaatt ggccgttcgg aaccggggcg ggccccccgg cgcaacagca gcccgagtac 180
ccggaacaag cggacctgga agacgtgctg cggacggtgg gaacgttccc gcccatcgtc 240
ttcgccggcg aggcgcgcac cctcgaggag cgcctcgcg aggcgcgcgt cggccggggc 300
ttcctcctcc agggcgggcg ctgcgccgag agcttcaagg agttcaacgc caacaacatc 360
agggacacct tccgcgtcct cctgcaaatg tccgttgtgc tcatgttcgg aggccagatg 420
cctgtcgtca aggtgggaag aatggcaagt cagtttgca ag 462

<210> 95
<211> 436
<212> DNA
<213> Zea mays

<400> 95
cagagaacag cgaacaaggt gataggtaca tggagttggc tcaccgagtt gacgaagctt 60
tggggttcat gtcagctgct gggctccctt tagatcacc tataatgaca acagcagaat 120
tttgagctc acatgagtgt cttctttctac cttatgagca agcgtcact cgtgaggatt 180
ccaccacggg cctctattat gactgctctg cccacttcct atgggtcgga gagcgactc 240
gccagcttga tgggtgctcac gttgagttcc ttcgaggcat tgccaaccct cttggtatca 300
aggttagtga caagatggac ccagcagaac ttgtgcgggt gattgatata ttgaatcccg 360
aaaacagggc tgggagaata accatcatca caagaatggg acctgaaaac atgagggtga 420
aacttcaca cctgat 436

<210> 96
<211> 472
<212> DNA
<213> Zea mays

<400> 96
ggttaatagg tacatggagt tggctcaccg agttgaogaa gctttggggg tcatgtcagg 60
tgctgggctc ccttagatc accctataat gacaacagca gaattttgga cgtcacatga 120
gtgtcttctt ctaccttatg agcaagcgt cactcgtgag gattccacca cgggcctcta 180

ttatgactgc tctgcccact tcctatgggt cggagagcgc actcgccagc ttgatggtgc 240
tcacgttgag ttccttcgag gcattgcca cctcttgggt atcaaggta gtgacaagat 300
ggacccagca gaacttggtc ggttgattga tatattgaat cccgaaaaca gggctgggag 360
aataaccatc atcacaagaa tgggacctga aaacatgagg gtgaaacttc cacacctgat 420
acgcgctgtc ccgtgggccg gtcagatagg tacatgggtt actgacccaa tg 472

<210> 97
<211> 427
<212> DNA
<213> Zea mays

<400> 97

tgacctgagc gaccgctacc acaccactg tgaccaagg ctgaacgct cccagtcgct 60
ggagctcgcc ttcattcattg cagagaggct caggaaggag acgatgccgt cggggctcaa 120
caacagcctg cctctgccac cactggcttt ctaagtagcc gaagctgaac agagaaggta 180
gagggatagt tgcggcgact cgaaagatta cgctgttta tttgctgatg cttggtgtgg 240
aggcctggcg ggcgctcttg gcacaagtta catgctgggg agctatagga gggtagctgt 300
tgcgttgtgg aagacagtag ctagtattat gtgttgtaat tgtatgcctt cgattcatgt 360
tctgagtgcg tgacttgctg actttgctgc ttctgggggt ctgaccttgg taaggagaga 420
atataga 427

<210> 98
<211> 220
<212> DNA
<213> Zea mays

<400> 98

cggagaatga gctgcttgtc ccaactgaagg ctgctctcct agatattggg aaagaaagga 60
aggaagcatg gattagttgg gtacagactt atattgaaga gctgggtggag agcggcgttc 120
ctgatgaaga aaggaaagcc gcgatgaact ctgttaatcc aaagtatatt ctccgcaact 180
atctctgcca gtacactatc gacgcagctg cagcagggca 220

<210> 99
<211> 293

<212> DNA
 <213> Zea mays
 <400> 99
 acctggtgca atagtttgtc gtgtagcacc gtcttttttta cgttttgggtt cgtatcagat 60
 acacgcttca agggggcaaag aggacattga gattgttcgt cgttttggcag actacacgat 120
 acatcatcac tttccacatc ttgaaaatat gaaaaagagt gaagggtttgt cattcgagac 180
 agctatagga gattcccca caatagatct cacatcaaac aaatatgcag cttgggcagt 240
 tgagggtggcg gagaggactg cttacttgat agctagatgg caagggtgttg gct 293

<210> 100
 <211> 261
 <212> DNA
 <213> Glycine max

<400> 100
 ccgacaagcc caagcccca gccaacaat ctgcatcccc ggccgcggcc cgtgcaacca 60
 aatggggccgt ggacagctgg aagtccaaga aggccctgca gctgcccga taccccaacc 120
 aggaggatct cgaggccgtc ctccgcaccc tcgacgcttc cgtcacatc gtcttcgccg 180
 gcgaggcccg gacactcgag gagcacctcg ccgatgcgc catgggaaat gccttcttcc 240
 tcaatggcgg agactgtgcc g 261

<210> 101
 <211> 257
 <212> DNA
 <213> Glycine max

<400> 101
 caccttcac atggctgagt tcttcttccc aaacaagtcg gtcggcgacc agaacagtgt 60
 cgaggattgg cgcacccgcg gcatgactcc tttgactcct cccgatctcc tccagcatga 120
 aattcgccag acagacaagt caagagagac tgtcgtcaag tcccgcaaag aggctgtcga 180
 ggctgtacac ggcgtggacg agaagaggag actcatgggtt tcattgggtcc ttgctccatc 240
 cacgaccctg ccatggc 257

<210> 102
 <211> 236

<212> DNA
 <213> Glycine max
 <400> 102
 ctcccttatg agcaagcact tactagggag gattctacta ctgggcttca ttatgattgc 60
 tcagctcaca tgctatgggt tggggaacgt acccgccaac ttgatgggtgc tcatgttgaa 120
 ttcttgagag gagttgctaa tccacttggc atcaagggtga gtgataagat ggttcccgat 180
 gaacttgтта agctgataga tattctgaac cctaaaaaca agcctggaag aattac 236

<210> 103
 <211> 245
 <212> DNA
 <213> Glycine max
 <400> 103
 cgccggtgag gccaggacat tggaggagca tctcgccgag gccgccatgg gaaatgcctt 60
 cctcctccag ggcggagact gtgctgagag cttcaaggag ttcaatgcc acaacatccg 120
 tgacaccttc cgcacatcc tccagatgag cgtcgtcatg atgttcggcg gccaaatgcc 180
 tgtcatcaag gtggggagaa tggcggggca atttgcaaag cctcgttcgg attcgtttga 240
 ggagc 245

<210> 104
 <211> 255
 <212> DNA
 <213> Glycine max
 <400> 104
 ttttagaact ttaatctcaa aatgtattca atattctttt gaaaatataa ttcataaacg 60
 attttaaaac accacctcgc cgaggccgcc atgggaaatg ccttctcct ccagggcgga 120
 gactgtgccg agagcttcaa ggagttcaat gccacaaca tccgtgacac cttccgcac 180
 atcctccaga tgagcgtcgt catgatgttc ggcgggccaaa tgcccgtcat caaggtgggg 240
 agaatggcgg ggcaa 255

<210> 105
 <211> 254
 <212> DNA
 <213> Glycine max

<400> 105

aagatgacgg gtcagaatgt gaccgagtgc attggtgggt caaggacggt cacatttgat 60
gacttgagct cacgtaccca cacacactgt gacccaaggc tcaatgcttc acaatctctt 120
gagcttgcta tcatcatcgc cgagcgtttg agaaagagca ggatcagatc gcagcaacct 180
cttgcccctc taggagtgtg aaagtgcctt caaaaccaac aagagaaaga tatttttgtt 240
cttttttttt tttg 254

<210> 106

<211> 278

<212> DNA

<213> Glycine max

<400> 106

ggagaatggc ggggcaattt gcaaagcctc gttcggattc gtttgaggag aagaatggcg 60
tgaagcttcc gagttacaga ggggataaca ttaacggaga ctctttcgac gagaagtcga 120
ggattccgga tccgcagagg atgattaggg cttattgcca agccgcgggc acgctgaatc 180
ttctcagagc ttttgccacc ggtggttatg ctgctatgca gagggttact cagtgggaatt 240
tggacttcac ggatcacagc gaacagggag ataggtag 278

<210> 107

<211> 267

<212> DNA

<213> Glycine max

<400> 107

attcgtttga ggagaagaat ggcgtgaagc ttccgagtta cagaggggat aacattaacg 60
gagactcttt cgacgagaag tcgaggattc cggatccgca gaggatgatt agggcttatt 120
gccaaagccg gccacgctg aatctttctca gagcttttgc caccggtggt tatgctgcta 180
tgcagagggg tactcagtgg aatttgact tcacggatca cagcgaacag ggagataggt 240
accgagagct tgctaaccga gttgatg 267

<210> 108

<211> 267

<212> DNA

<213> Glycine max

<400> 108

tcggcggcca aatgcccgtc atcaaggtgg ggagaatggc ggggcaattt gcgaagcgag 60
gtcggattcg tttgaggaga agaacggcgt gaagcttccg agttacagag gggacaacat 120
taacggagac tcctttgacg agaagtcgag gattccggat ccgcagagga tgattagggc 180
ttattgcaa gccgcggcga cgctgaatct tctcagagct ttgccaccg gtggttatgc 240
tgctatgcag agggttactc agtggaa 267

<210> 109

<211> 247

<212> DNA

<213> Glycine max

<400> 109

gggagaatgg cggggcaatt tgcaaagcct cgttcggatt cgtttgagga gaagaatggc 60
gtgaagcttc cgagttacag aggggataac attaacggag actctttcga cgagaagtcg 120
aggattccgg atccgcagag gatgattagg gcttattgcc aagccgcggc cacgctgaat 180
cttctcagag cttttgccac cgggtggttat gctgctatgc agagggttac tcagtggaat 240
ttggact 247

<210> 110

<211> 263

<212> DNA

<213> Glycine max

<400> 110

catccgtgac accttccgca tcatcctcca gatgagcgtc gtcattgatgt tcggcggcca 60
aatgcccgtc atcaaggtgg ggagaatggc ggggcaattt gcgaaccgag gtcggattcg 120
tttgaggaga agaacggcgt gaagcttccg agttacagag gggacaacat taacggagac 180
tcctttgacg agaagtcgag gattccggat ccgcagagga tgattagggc ttattgcaa 240
gccgcggcga cgctgaatct tct 263

<210> 111

<211> 247

<212> DNA

<213> Glycine max

<400> 111

ctcgagccga ttcggctcga ggaggggata acattaacgg agactacttt cgacgagaag 60
tcgcggattc cggatccgca gaagatgatt agggcttatt gccaaagccgc ggccacgctg 120
aatcttctca gagcttttgc caccggtggt tatgctgcta tgcagagggt tactcagtgg 180
aatttgact tcacggatca cagcgaacag ggagataggt accgagagct tgctaaccga 240
gttgatg 247

<210> 112

<211> 217

<212> DNA

<213> Glycine max

<223> unsure at all n locations

<400> 112

aatttgtaaa gctctcgact cggatattcgt tttgaggaga agtaatgggc gtgaagcttt 60
ccgagttaca gaggtggata actgttaacg tgtagactct ttcgacgtat tagtcgagtg 120
attccggatc cgcataggat gatnagggt tatcgccatt ccgaggctac gctgaatctt 180
ctcatagctt tttccaccgg tggttatgct gctatgc 217

<210> 113

<211> 228

<212> DNA

<213> Glycine max

<400> 113

cgaggtcggg ttcgtttgag gagaagaacg gcgtgaagct tccgagttac agatgggaca 60
acattaacgg agactcgttt gacgataagt cgaggattcc ggatccgcag aggatgatta 120
gggcttattg ccaagccgcg gcgacgctga atcttctcag agctttcgcc accggtgggt 180
atgctgctat gcacacgggt actcagtggg atttggactt cacggatc 228

<210> 114

<211> 310

<212> DNA

<213> Glycine max

<223> unsure at all n locations

<400> 114

tccaaacaca ccaattgcat ttgcattacc attcacaatg gcaatctcct ccacttccaa 60
 ctccctcatt cccaccaaat ctctantccc ccaatcccac cccctcattc ccaacaccag 120
 gcccgccctc cggcccaagc cgggccatc accttccatc ntgcgcgttc acgccgccga 180
 gcccgccaaa aaccccgtcg tcaccgacaa gcccaagccc caagcccaac aacctccccc 240
 ggccctcgcc cgggcaacga aatgggcccgt ggacagctgg aagtnccaga aagccctgca 300
 gctgcccgaa 310

<210> 115
 <211> 284
 <212> DNA
 <213> Glycine max

<400> 115

aaacacacca attgcatttg cattaccatt cacaatggca atctcctcca cttccaactc 60
 cctcattccc accaaatctc taatccccca atcccacccc ctcatccca acaccaggcc 120
 cgccctccgg cccaagcccg gcccatcccc ttccatcttc gccgttcacg ccgccgagcc 180
 cgccaaaaac cccgtcgtca ccgacaagcc caagcccca gccaacaac ctcccccgcc 240
 ctgggcccg gcaacgaaat gggccgtgga cagctggaag tcaa 284

<210> 116
 <211> 286
 <212> DNA
 <213> Glycine max

<400> 116

cacaatggca atctcctcca cttccaactc cctcattccc accaaatctc taatccccca 60
 atcccacccc ctcatccca acaccaggcc cgccctccgg cccaagcccg gcccatcccc 120
 ttccatcttc gccgttcacg ccgccgagcc cgccaaaaac cccgtcgtca ccgacaagcc 180
 caagcccca gccaacaac ctcccccgcc ctgggcccg gcaacgaaat gggccgtgga 240
 cagctggaag tcaaagaaag ccctgcagct gccgaatac ccgagc 286

<210> 117
 <211> 285
 <212> DNA
 <213> Glycine max

<400> 117
 gggagaagct cgctcaggct gccatgggga acgcttttct ccttcagggc ggtgattgcg 60
 ccgagagctt caaggaattc actgccaaaca acatccgtga caccttccgt gtcacccctc 120
 aaatgggtgt ggtcctcatg ttcggtggcc aaatgcccggt tatcaagggtg gggagaatgg 180
 caggtcaatt tgcaaagccg agatccgatt catttgagga gaagaatgga gtgacgctcc 240
 cgattacagg ggtgataatg tgaatggcga tgcatttgac gcggc 285

<210> 118
 <211> 176
 <212> DNA
 <213> Glycine max

<400> 118
 atccttcaaa tgggtgttgt cctcatgttc ggtggccaaa tgcccgttat caaggtgggg 60
 agaatggcag gtcaatttgc aaagccgaga tccgattcat ttgaggagaa gaatggagtg 120
 acgctcccga gttacagggg tgataatgtg aatggcgatg catttgacgc ggcac 176

<210> 119
 <211> 249
 <212> DNA
 <213> Glycine max

<400> 119
 cagatgcgaa tgaattggac ctagtcctcc aaaccctctc ttcttttccc ccaatcgtct 60
 tcgccggcga ggcgaggaat ctggaggaga agctcgctca ggctgccatg gggaacgctt 120
 ttctccttca gggcggtgat tgcgccgaga gcttcaagga attcactgcc aacaacatcc 180
 gtgacaccta ccgtgtcatc cttcaaattg gtgtggctct catgttcggt ggccaaatgc 240
 ccgttatca 249

<210> 120
 <211> 269
 <212> DNA
 <213> Glycine max

<400> 120
 cccagatgcg aatgaattgg acctagtcct ccacaccctc tcttcttttc cccaatcgt 60

cttcgccggc gaggcgagga atctggagga gaagctcgct caggctgccca tcgggaacgc 120
 ttttctcctt cagggcggtg attgcgccga gagcttcaag gaattcactg ccaacaacat 180
 ccgtgacacc ttccgtgtca tccttcaa at ggggtgtggc ctcatgttcg gtggccaaat 240
 gcccgttatc aaggtgggga gaatggcag 269

<210> 121
 <211> 270
 <212> DNA
 <213> Glycine max
 <223> unsure at all n locations
 <400> 121

gaacgtaccc gccaaactga tgggtgctcat gttgaattct tgagaggagt tgctaatacca 60
 cttggcatca aggtgagtga taagatgggt cccgatgaac ttgttaagct gatagatatt 120
 ctgaacccta aaaacaagcc tggaagaatt acagtcattg ttagaatggg agctgagaat 180
 atgcgagtga agcttccaca tcttatcagg gcagttcgca gagcagggtca attgtcactt 240
 gggttagtga cnccatgcat gggaacacca 270

<210> 122
 <211> 255
 <212> DNA
 <213> Glycine max
 <223> unsure at all n locations
 <400> 122

aatccacttg gcatcaaggt gaggatgaag atgggtcccg atgaacttgt taagctgata 60
 gatattctga accctaaaaa caagcctgga agaattacag ttattgttag aatgggagct 120
 gagaatatgc gaggtaagct tccacatctt atcagggcag ttgcgagagc aggtcaaatt 180
 gtcacttggg ttagtgacct catgcatggg aacaccatta aagctccatc tggacttaaa 240
 accgctcttt tgang 255

<210> 123
 <211> 266
 <212> DNA
 <213> Glycine max
 <223> unsure at all n locations

<400> 123

tgaaccctaa aaacaagcct ggaagaatta cagtcattgt tagaatggga gctgagaata 60

tgcgagtga gcttcncaca tcttatcagg gcngttcgca gagcagggtca aattgtcact 120

tggttnnagt accccatgca tgggaacacc attaaagctc catctggact taaaacccgc 180

tnttntgatg caataagggc tgagctgagg gcnttnnnnn nngtgcagat caagaaggaa 240

gctaccagg aggggttcat tagaga 266

<210> 124

<211> 258

<212> DNA

<213> Glycine max

<400> 124

ggttactcag tgggaatttg acttcacgga tcacagcgaa cagggagata ggtaccgaga 60

gcttgctaac cgagttgatg aggctcttgg attcatggct gctgctgggc tcacagtgga 120

ccatcccata atgagaacaa ctgaattctg gacatctcat gagtgccttat tgttgcctta 180

tgaacaatcc ctcaccagg tggattcaac ttctgggtct tactatgact gttcagccca 240

tatgctctgg gttggggga 258

<210> 125

<211> 241

<212> DNA

<213> Glycine max

<400> 125

ggttactcag tgggaatttg acttcacgga tcacagcgaa cagggagata ggtaccgaga 60

gcttgctaac cgagttgatg aggctcttgg attcatggct gctgctgggc tcacagtgga 120

ccatcccata atgagaacaa ctgaattctg gacatctcat gagtgccttat tgttgcctta 180

tgaacaatcc ctcaccagg tggattcaac ttctgggtct tactatgact gttcagccca 240

t 241

<210> 126

<211> 228

<212> DNA

<213> Glycine max

<400> 126

agtatcgaga gcttgctaac cgagttgatg aggctcttgg attcatggct gctgctgggc 60
tcacagtgga ccatcccata atgagaacaa ctgaattctg gacatctcat gagtgttat 120
tgttgcctta tgaacaatcc ctcaccaggt tggattcaac ttctggtctc tactatgact 180
gttcagccca tatgctctgg gttggggaac gaaccaggca gcttgatg 228

<210> 127

<211> 253

<212> DNA

<213> Glycine max

<400> 127

ttcagtggaa tttggacttc acggatcaca gcgaacaggg agataggtac cgagagcttg 60
ctaaccgagt tgatgaggcc cttggattca tggctgctgc tgggctcacg gtggaccatc 120
ccataatgag aacaactgaa ttctggacat ctcatgagtg cttattgttg ccttatgaac 180
aatccctcac aaggttggat tcaacttctg gtctctacta tgactgttca gcccatatga 240
tctggggttg aga 253

<210> 128

<211> 289

<212> DNA

<213> Glycine max

<400> 128

tacggctgcg agaagacgac agaaagggag gtaccgagag cttgctaacc gagttgatga 60
ggcccttgga ttcatggctg ctgctgggct cacgggtggac catcccataa tgagaacaac 120
tgaattctgg acatctcatg agtgcttatt gttgcattat gaacaatccc tcacaagggt 180
ggattcaact tctggtctct actatgactg ttcagcccat atgatctggg ttggagaacg 240
aaccaggcag cttgatggtg cccatgttga gtttctaaga ggagttgct 289

<210> 129

<211> 295

<212> DNA

<213> Glycine max

<223> unsure at all n locations

<400> 129

gaaccaggca gcttgatggt gcccatgttg agtttctaag aggagttgct aatcccttgg 60
gaattaaggt aagtgacaag atggatccaa atgagctagt taaactcatt gagatcttga 120
atcctcaaaa caaagcagga agaattactg tgatcacgng atgggagctg aaaatatgag 180
ggtgaagctt ccacatctca tcagggcagt gcgcagagca ggccaaattg tcacttgggt 240
cagtgatect atgcatggaa acaccattaa ggctccctgt ggtcttaaaa ctgcg 295

<210> 130
<211> 269
<212> DNA
<213> Glycine max
<400> 130

ttccacatct catcagggca gtgcgcagag caggccaaat tgtcacttgg gtcagtgate 60
ctatgcatgg aaacaccatt aaggctccct gtggtottaa aactcgcccc ttcgattcca 120
tcagggccga agtgagagca ttcttcgacg tacacgagca agaaggaagc caccaggag 180
gggttcatct agagatgacg ggtcagaatg tgaccgagtg cattgggtggg tcaaggacgg 240
tcacatttga tgacttgagc tcacgttac 269

<210> 131
<211> 269
<212> DNA
<213> Glycine max
<400> 131

gaacaactga attctggaca tctcatgagt gottattggt gccttatgaa caatccctca 60
ccaggttgga ttcaacttct ggtctctact atgactgttc agcccatatg ctctggggtg 120
gggaacgaac caggcagctt gatggtgccc atgtcgagtt tctaagagga gttgctaata 180
ccttggggaat taaggtaagt gacaagatgg atccaaatga gcttggttaga ctcatgaga 240
tcttgaatcc ccaaaacaaa ccagggaga 269

<210> 132
<211> 259
<212> DNA
<213> Glycine max
<400> 132

cggtctcgagt gaaaatatga ggggtgaagct tccacatctc atcagggcag tgcgcagagc 60
aggccaaatt gtcacttggg tcagtgatcc tatgcatgga aacaccatta aggtccctg 120
tggtcttaaa actcgccctt tcgattccat cagggccgaa gtgagagcat tcttcgacgt 180
acacgatcaa gaaggaagcc acccaggagg ggttcatcta gagatgacgg gtcagaatgt 240
gacctagtgc attggtggg 259

<210> 133
<211> 243
<212> DNA
<213> Glycine max
<400> 133

tggacatctc atgagtgctt attgttgctt tatgaacaat ccctcaccag gttggattca 60
acttctggtc tctactatga ctgttcagcc cataatgctct gggttgggga acgaaccagg 120
cagcttgatg gtgcccatgt cgagtttcta agaggagtgt ctaatccctt gggaattaag 180
gtaagtgaca agatggatcc aaatgagctt gttagactca ttgagatctt gaatcccca 240
aac 243

<210> 134
<211> 294
<212> DNA
<213> Glycine max
<223> unsure at all n locations
<400> 134

gagcttggtta gactcantgn natcttgaat ccccaaaaca aaccagggag nataactgtg 60
attachanga tgggagctgn aaatatgagg gtgaagcttc cacatcttca tcagggcagt 120
gcgcagagca gggcaaattg tcacctgggt cagtgatcta tgcattgaaa caccattaag 180
gctccatngg gtcttaaaac ttcgcccctt cgattcatca gggctgaagt gagagcattc 240
tttgnngtgc acgagcaaga aggaagccac ccagganggg ttcattctaga gatg 294

<210> 135
<211> 278
<212> DNA
<213> Glycine max

<400> 135

gttgagaaga gagaatggct gtggcgctgt catcatccct tatcacgttg aaggtgaaac 60
ottgcatttt cgggtctcct cggagatccg cggtggttcg gaattgtgcg aagtcaacgg 120
cggggacaat atcgacgagt tggagcctgg acagctggag ggcgaagaag gcgcttcagc 180
ttccggagta cccagatgcg aatgaattgg acctagtcct ccaaaccctc tcttcttttc 240
ccccaatcgt cttcgccggc gagggcgagga atctggag 278

<210> 136

<211> 254

<212> DNA

<213> Glycine max

<400> 136

attttgttga gaagagagaa tggtgtggc gtggtcatca tcccttatca cgttgaaggt 60
gaaaccttgc attttcgggt ctcctcggag atccgcggtg gttcgggaatt gtgcgaagtc 120
aacggcgggg acaatatcga cgagttggag cctggacagc tggagggcga agaaggcgct 180
tcagcttccg gagtaccag atgcgaatga attggaccta gtccctccaaa ccctctcttc 240
ttttcccca atcg 254

<210> 137

<211> 256

<212> DNA

<213> Glycine max

<400> 137

tgtttttttg ttgagaagag agaatggctg tggcgctgtc atcatccctt atcacgttga 60
aggtgaaacc ttgcattttc gggctctctc ggagatccgc ggtgggttcgg aattgtgcga 120
agtcaacggc ggggacaata tcgacgagtt ggagcctgga cagctggagg gcgaagaagg 180
cgcttcagct tccggagtac ccagatgcga atgaattgga cctagtcctc caaaccctct 240
cttcttttcc cccaat 256

<210> 138

<211> 245

<212> DNA

<213> Glycine max

<400> 138

ttttgttgag aagagagaat ggctgtggcg tcgtcatcat cccttatcac gttgaagggtg 60
aaacottgca ttttogggtc toctcggaga tccgcggtgg ttcggaattg tgcgaagtca 120
acggcgggga caatatcgat cagttggagc ctggacagct ggagggcgaa gaaggcgctt 180
cagcttcccg agtaccacaga tgcgaatgaa ttggacctag tcctccaaac cctctcttct 240
tttcc 245

<210> 139

<211> 240

<212> DNA

<213> Glycine max

<400> 139

tttgtttttt tgttgagaag agagaatggc tgtggcgctc tcatcatccc ttatcacgtt 60
gaaggtgaaa ctttgcattt tcgggtctcc tcggagatcc gcggtgggtc ggaattgtgc 120
gaagtcaacg gcggggacaa tatcgacgag ttggagcctg gacagctgga gggcgaagaa 180
ggcgcttcag cttccggagt acccagatgc gaatgaattg gacctagtcc tccaaacctt 240

<210> 140

<211> 258

<212> DNA

<213> Glycine max

<223> unsure at all n locations

<400> 140

gtttttttgt tgagaagaga gaatggctgt ggcgtcgtca tcatccctta tcacgttgaa 60
ggtgaaacct tgcattttcg ggtctcctcg gagatccgcg gtggttcgga attgtggcga 120
agtcaacggc ggggacaata tcgacgagtt ggagcctgga cagctggagg gcgaagaagg 180
cgcttcagct tccggagtac ccagatgcga atgaattgga ctaatncttc aaaacnctct 240
cttctttccc ccaatngt 258

<210> 141

<211> 247

<212> DNA

<213> Glycine max

<400> 141

gttggtttgt ttttttgttg agaagagaga atggctgtgg cgtcgtcatc atcccttata 60
acgttgaagg tgaaaacttgc attttcgggt ctctcggag atccgcggtg gttcgggaatt 120
gtgcgaagtc aacggcgggg acaatatcga cgagttggag cctggacagc tggagggcga 180
agaaggcgct tcagcttccg gagtaccag atgcgaatga attggaccta gtcctccaaa 240
ccctctc 247

<210> 142
<211> 251
<212> DNA
<213> Glycine max
<400> 142

ctcgagccga atcggctcga ggtttttttg ttgagaagag agaacggctg tggcgtcgtc 60
atcatccctt atcacgttga cggtgaaacc ttgcattttc ggggtctctc ggagatccgc 120
ggtggttcgg aattgtgcga agtcaacggc ggggacaata tcgacgagtt ggagcctgga 180
cagctggagg gcgaagaagg cgcttcagct tccggagtac ccagatgcga atgaattgga 240
cctagtcctc c 251

<210> 143
<211> 352
<212> DNA
<213> Glycine max
<400> 143

gaatggagtg acgctcccga gttacagggg tgataatgtg aatggcgatg catttgacgc 60
ggcatctaga atccccgatc cacagaggat gataagagcc tactgccaat ctgtgtctac 120
tctgaacctt ttgcgggcat ttgccacggg aggttatgct gccatgcaaa gggttaatca 180
atggaatctt gatttcatgg agcatagtga acagggagac aggtaccgtg aattagccca 240
tagagtggat gaggctcttg gttcatgaa tgttgctggg ctacagccg accatcccat 300
catgagtaca acagactttt ggacctccca tgagtgtttg cttctccctt at 352

<210> 144
<211> 239
<212> DNA
<213> Glycine max

<400> 144

caaagggtta atcaatggaa tcttgatttc atggagcata gtgaacaggg agacaggtac 60
cgtgaattag cccatagagt ggatgaggct cttggcttca tgaatgttgc tgggctcaca 120
gccgaccatc ccatcatgag tacaacagac ttttggacct cccatgagtg tttgcttctc 180
ccttatgagc aagcacttac tagggaggat tctactactg ggcttcatta tgattgctc 239

<210> 145

<211> 264

<212> DNA

<213> Glycine max

<400> 145

cagctggaag tcaaagaaag ccctgcagct gccgaatac ccgagccagg aggagctgga 60
gtccgtcctc aaaaccctcg aggccttttcc tccaatcgtc ttcgccggtg aggccaggac 120
attggaggag catctcgccg aggcgcgccat gggaaatgcc ttcctcctcc agggcggaga 180
ctgtgctgag agcttcaagg agttcaatgc caacaacatc cgtgacacct tccgcatcat 240
cctccagatg agcgtcgtca tgat 264

<210> 146

<211> 223

<212> DNA

<213> Glycine max

<400> 146

acgaaatggg ccgtggacag ctggaagtca aagacagccc tgcagctgcc cgaatacccg 60
agccaggagg agctggagtc cgtcctcaaa accctcgagg cttttcctcc aatcgtcttc 120
gccggtgagg ccaggacatt ggaggagcat ctgcgcgagg ccgccatggg aaatgccttc 180
ctcctccagg gcggagactg tgctgagagc ttcaaggagt cat 223

<210> 147

<211> 224

<212> DNA

<213> Glycine max

<400> 147

ccactaaagt ctgtactgtt agatattggg aaagagcgta aggaagcatg gaccagttgg 60

ttgaaagctt atatacatga ggtctctacc agtgggatac ctgatgacga aaggaagatc 120
 tcgatggatt cagtgaatcc taaatatata ctgaggaact atctctgcc a gactgcaatt 180
 gatgctgcag aaataggtga ttttggagag gttcgcagcc tgct 224

<210> 148
 <211> 265
 <212> DNA
 <213> Glycine max

<400> 148

acggaagacg acagaagggg acgaaaggaa gatctcgatg gattcagtga atcctaaata 60
 tatactgagg aactatctct gccagactgc aattgatgct gcagaaatag gtgattttgg 120
 agaggttcgc agcctgctca aattagtgga gcatccgtat gatgagcaac caggaatgga 180
 aaaatatgct cgttgcccc cagcttgggc atatcgacca ggtgtatgca tgctttcttg 240
 ttcttcatga ggctcccatt taggt 265

<210> 149
 <211> 276
 <212> DNA
 <213> Glycine max

<223> unsure at all n locations
 <400> 149

cccaggtcga agatactgtt ttcnaacca gctgacatt ggtttgtgga atattgcaca 60
 gttcacaaca aactacaan ctgctcatTT aataaatgan aaagaggcca actatgctat 120
 ggaaagatat ggaacgagat ttatggatga ttatcaggtt acaatgacca aaaagcttgg 180
 cctccctaag tataataagc agatgattaa taaacttctt agcaatatgg ctgttgacaa 240
 agttgattac acanacttct ttctgtacgt ttcaac 276

<210> 150
 <211> 266
 <212> DNA
 <213> Glycine max

<400> 150

gttttgcaaa ccagcctgac attggtttgt ggaatattgc acagttcaca acaacactac 60

aagctgctca ttttaataaat gaaaaagagg ccaactatgc tatggaaaga tatggaacga 120
gatttatgga tgattatcag gttacaatga ccaaaaagct tggcctccct aagtataata 180
agcagatgat taataaactt cttagcagta tggctgttga caaagttgat tacacaaact 240
tctttcgtac gctttcaaat gttaaa 266

<210> 151
<211> 392
<212> DNA
<213> Glycine max
<400> 151

gttcccgatg aacttggttaa gctgatagat attctgaacc ctaaaaacaa gcctggaaga 60
attacagtca ttgttagaat gggagctgag aatatgagag tgaagcttcc acatcttattc 120
agggcagttc gcagagcagg tcaaattgtc acttgggtta gtgaccccat gcatgggaac 180
accattaaag ctccatctgg acttaaaacc cgctcttttg atgcaataag ggctgagctg 240
agggcattct ttgatgtgca tgatcaagaa ggaagctacc caggaggggt tcatttagag 300
atgacagggc agaacgtgac agaatgtggt ggaggctcaa ggactattac ttatgatgac 360
ttgagctcac gctaccacac acattgtgat cc 392

<210> 152
<211> 359
<212> DNA
<213> Glycine max
<400> 152

ctgttttttt gctgagaaga gagaatggct gtggcgtggt catcatccct tatcacgttg 60
aaggtgaaac cttgcatttt cgggtctcct cggagatccg cgggtggatcg gaattgtgcg 120
aagtcaacgg cggggacaat atcgacgagt tggagcctgg acagttggag ggcgaagaag 180
gcgcttcagc ttccggagta ccagatgag gaaagatgaa ttggacctag tccttcaaac 240
cctatgttct tttcccccaa tcgtcttcgg cggcgaggcg aggaatctgg aggagaagct 300
agctcaggct gccatgggga acgcttatct gcttcagggc ggtgattgcg ccgagagct 359

<210> 153
<211> 167
<212> DNA

[illegible]

gcggattcat ctgtaggcgg gaaaacggggg attaaccacc cactagggaa gaacttgatt 60
ggacgattct catcagccac aatgtgttct aattgacaca gctacactga acacattgcc 120
tgacagggag ctagcctcag gcattgccga ggtagtgaag tatgggc 167

<210> 154

<211> 235

<212> DNA

<213> Zea mays

<400> 154

cggatatgga	gcatggctcc	atggggaggc	tgtcgcagct	ggaacagtta	tggaactga	60
catgtctcac	cgcctgggggt	ggatagatga	ctccatcaga	aaacgtgttg	ttgacatact	120
aaagcaagcc	aaacttccca	ttgcacctcc	tgagaccatg	accgtagaga	agttttaaaaa	180
catcatggct	gttgacaaga	aggttgctga	tggtctgttg	agactcatcc	ttctg	235

<210> 155

<211> 248

<212> DNA

<213> Zea mays

<400> 155

aagagggttc	tggtggtgac	caacacgacc	gtcgcgcgcg	tttacctgga	caaggtgaca	60
tgggcactca	cccacaacaa	cctgaatgta	tcagtggaaa	gogtgatcct	gcccgacggt	120
gaaaagtaca	aaaatatgga	cacgctgatg	aaggtgtttg	acaaggcagt	cgagtcccg	180
tttgaccgcc	ggtgcacatt	tgtagcactg	ggtggtggtg	tcattgggga	catgtgtggt	240
tttgcagc						248

<210> 156

<211> 284

<212> DNA

<213> Zea mays

<400> 156

ggcatgttca tggtaagagg gttctggtgg tgaccaaacac gaccgtcgcg ccgctttacc 60

tggacaaggt gacatgggca ctcacccaca acaacctgaa tgtatcagt gaaagcgtga 120
 tcctgcccga cggtgaaaag tacaaaaata tggacacgct gatgaaggtg tttgacaagg 180
 cagtcgagtc ccgtttttgac cgccggtgca catttgtagc actgggtggt ggtgtcattg 240
 gggacatgtg tggttttgca gctgctgcat tcctccgggg cgtc 284

<210> 157
 <211> 473
 <212> DNA
 <213> Zea mays

<223> unsure at all n locations
 <400> 157

gtggagttgc acgtcttcgc agccacggtc tagtaatccg gctcgccnca cgcgtcaggc 60
 tgaagtgggtg gcacaagatg agaaggaaaag tggccttcga gcaacactaa acctgggtca 120
 cacatttggc catgctattg agactgggac aggatatgga gcatggctcc atggggaggc 180
 tgtcgcagct ggaacagtta tggcaactga catgtctcac cgctgggggt ggatagatga 240
 ctccatcaga aaacgtgtgg ttgacatact aaagcaagcc aaacttccca ttgcacctcc 300
 tgagaccatg accgtagaga agtttaaaaa catcatggct gttgacaaga aggttgctga 360
 tgggtctgttg agactcatcc ttctgaaaagg accgctangg tgtgtgttat ttacggggga 420
 ttatgacggg aatgcactcg atgaaacctat catgcattct gcgacaactg aga 473

<210> 158
 <211> 182
 <212> DNA
 <213> Zea mays

<400> 158

cggacgctgg gcggacgcgt gggggcagat agggccagac actaaggctt ttggtataat 60
 tggtaaacca gttggccata gcaaaagccc aattttgcac aatgaagctt tcagatcagt 120
 gggtttcaac gctgtgtatg ttccattttt ggtggatgac ttggctaaat ttcttgatac 180
 at 182

<210> 159
 <211> 251
 <212> DNA
 <213> Zea mays

<400> 159

gcttaaggtg gctgacaaat ttatgaaact tatttctggg aggaaacctg ataactgtaa 60
acttatagtt tcatcccaca actatgagac caatccatcg tccgaggaac ttgcaaattt 120
ggtggctcag attcaagcaa cgggggctga tatcgtgaaa atagctacaa ccgctactga 180
aattgttgat gtggcaaaaa tgtttcaaat acttgttcac tgccaggaaa agcaggtgcc 240
aatcattggg c 251

<210> 160

<211> 251

<212> DNA

<213> Glycine max

<400> 160

caacgctttg tctaccgctc cggcagcggg tagtaggaag aacgcgacgc taatttgctg 60
cccaataatg ggagaatcag ttgaaaagat ggagattgac gtggacaaaag cgaaagccgg 120
aggcgcggac cttgttgaaa ttcgattgga ttctttgaaa acctttgacc cctatcgaga 180
tctcaacgct ttcattcaac accgttcttt acccttggtg ttcaattaca ggcccaaattg 240
ggaggggtggt a 251

<210> 161

<211> 225

<212> DNA

<213> Zea mays

<400> 161

attgttggaa tgatgggttc aggcaaaact acagttggga agatattatc cgaagtgtta 60
ggttattcgt tcttcgacag tgataagttg gtagagaagg ctggttggtat ttcattctgtt 120
gctgagatct ttcagctcca tagcgaacaa ttcttcagag ataatgagga gttacatgaa 180
gaaagggctg accgtatggt tagatgtccc actggatgca cttgc 225

<210> 162

<211> 297

<212> DNA

<213> Zea mays

<400> 162

cagttgcccc aatattcaag gtccatagtg aagccttctt tcgggataat gagagtagtg 60
tcttgagaga tttgtcctcc atgogacgat tagttgttgc caccggaggt gatgctgtta 120
tccgaccaat taactggaga tatatgaaga ggggcctatc tgtttgggta gatgtgccct 180
tggatgctct tgctaggcgt attgctaaag tgggaactgc ctctcgctct cttctggacc 240
aaccatctgg tgatccgtac gcaatggtag ctacttggtc ttgttccttc aaattct 297

<210> 163
<211> 249
<212> DNA
<213> Zea mays

<400> 163

ttcacaagct gttggaatcc cttcagttgc tcaaatatcc aaagttcaca gtgaagcctt 60
ctttcgggat aattggagta gcgctctcag ggatctgtcc tccatgacgac gattagttgt 120
tgccacggag gtgttctgtc atccgaccag ttaactggac atatatgaag atgggcctat 180
ccgttttggtt agatgtgccc ttagatgtct ttgctaggcg tattactaaa gtgggaccgc 240
ttctcgctcc 249

<210> 164
<211> 334
<212> DNA
<213> Zea mays

<400> 164

gaaatatatg aagaagggcc tatccgtttg gttagatgtg ccottggatg ctcttgctag 60
gcgcattgct aaagtgggaa ccgcttctcg tcctcttctg gaccaaccgt ccggtgatcc 120
atacacaatg gtagctactt attctttcaa tattctttca tgctcgtgaa acggaattgt 180
ttcttttttc tatttggaaca aagaactgct catagatcca cttgagcctt gaagccctat 240
cctggattcc agtcctttac ttgtggtagc aaatgctcag acttcttatg ctagttctaa 300
tatggatcac tcaactgggtt ccttattggt atag 334

<210> 165
<211> 273
<212> DNA
<213> Zea mays

<400> 165

atttacctag taggaatgat gggttctgga aaaagtactg tggggaagat tatgtctgaa 60

gtcttggggtt attcgttctt tgatagtac aagttagtgg agcaagctgt tggaatgcca 120

tcagttgccc aaatattcaa ggtccatagt gaagccttct ttcgggataa tgagagtagt 180

gtcttgagag atttgtcctc catgcgacga ttagttgttg ccaccggagt ggtgcctgtt 240

atccgaccaa ttaactggag atatatgaag agg 273

<210> 166

<211> 298

<212> DNA

<213> Zea mays

<400> 166

gatgggttct ggaaaaagta ctgtggggaa gatcatgtct gaagtcttgg gttattcgtt 60

ctttgatagt gacaaattag tggagcaagc tgttggaatg ccttcagttg ctcaaattt 120

caaagttcac agtgaagcct tctttcggga taatgagagt agcgtcttga gggatctgtc 180

ctccatgcga cgattagttg ttgccaccgg agtgggtgctg tcatccgacc agttaactgg 240

aaatatatga agaagggcct atcggtttgg ttagatgtgc ccttggatgc tcttgcta 298

<210> 167

<211> 297

<212> DNA

<213> Zea mays

<400> 167

agaagttctg ttctacttaa acgggaggtg tatttactta gtgggaatga tgggttctgg 60

aaaaagtact gtggggaaga tcatgtctga agtcttgggt tattcgttct ttgatagtga 120

caaattagtg gagcaagctg ttggaatgcc ttcagttgct caaatattca aagttcacag 180

tgaagccttc tttcgggata atgagagtag cgtcttgagg gatctgtcct ccatgcgacg 240

attagttgtt gccaccggag gtgggtgctgt catccgacca gttaaactgg aatatat 297

<210> 168

<211> 231

<212> DNA

<213> Zea mays

<400> 168

gaagctctcc tgttgaagag aaaatcagaa gaagttctgt tctacttaaa cgggaggtgt 60
atttacttag tgggaatgat gggttctgga aaaagtactg tggggaagat catgtctgaa 120
gtcttggggtt attcgttctt tgatagtgac aaattagtgag agcaagctgt tggaatgcct 180
tcagttgctc aaatattcaa agttcacagt gaagccttct ttcgggataa t 231

<210> 169

<211> 274

<212> DNA

<213> Zea mays

<400> 169

cccacgcgtc cgcccacgcg tccggaaga tcatgtctga agtcttgggt tattcgttct 60
ttgatagtga caaattagtg gagcaagctg ttggaatgcc ttcagttgct caaatattca 120
aagttcacag tgaagccttc tttcgggata atgagagtag cgtcttgagg gatctgtcct 180
ccatgcgacg attagttggt gccaccggag ggggtgctgt catccgacca gttaactgga 240
aatatatgaa gaagggccta tccgtttgggt taga 274

<210> 170

<211> 294

<212> DNA

<213> Zea mays

<400> 170

tgttcaggca aaactacagt tgggaagata ctatccgaag tgttagggtta ttcgttcttc 60
gacagtgata agttggtaga gaaggctggt ggtatttcat ctgttgctga gatctttcag 120
ctccatagcg aaacattctt cagagataat gagagtgagg tcctgacgga tctgtcatca 180
atgcatcggg ttggttgttg aacctggagt ggtgcagtga tccgaccaat caattggagt 240
tacatgaaga aagggtgac cgtatgggtta gatgtccac tggatgcact tgca 294

<210> 171

<211> 261

<212> DNA

<213> Zea mays

<400> 171

atccgaccaa tcaattggag ttacatgaag aaagggctga ccgtatgggt agatgtccca 60
ctggatgcac ttgcaagaag aatcgctgct gtaggaaccg cgtctcgacc actcttgcac 120
caggaatccg gtgatcctta tgcaaaggct tatgcaaaac ttacgtcact ttttgagcaa 180
agaatggact cgtatgctaa tgctgatgcc agagtttcac ttgaacatat tgcattaaaa 240
caaggccata atgatgtcac t 261

<210> 172
<211> 289
<212> DNA
<213> Zea mays

<400> 172

agtgagggcc tgacggatct gtcacatgaatg catcggttgg ttgttgcaac cggagggtggt 60
gcagtgatcc gaccaatcaa ttggagttac atgaagaaag ggctgaccgt atgggttagat 120
gtcccactgg atgcacttgc aagaagaatc gctgctgtag gaaccgcgtc tcgaccactc 180
ttgcatcagg aatccggtga tccttatgca aaggcttatg caaaacttac gtcacttttt 240
gagcaaagaa tggactcgta tgctaattgct gatgccagag tttcacttg 289

<210> 173
<211> 317
<212> DNA
<213> Zea mays

<400> 173

ctatccgaag tggttaggtta ttcgtttcttc gacagtgata agttggtaga gaaggctggt 60
ggtatttcat ctgttgctga gatctttcag ctccatagcg aaacattctt cagagataat 120
gaggagttac atgaagaaag ggctgaccgt atgggttagat gtcccactgg atgcacttgc 180
aagaagaatc gctgctgtag gaaccgcgtc tcgaccactc ttgcatcagg aatccggtga 240
tccttatgca aaggcttatg caaaacttac gtcacttttt gagcaaagaa tggactcgta 300
tgctaattgct gatgcc 317

<210> 174
<211> 231
<212> DNA
<213> Zea mays

<400> 174

ggcatgacta cagttgggaa gatactatcc gaagtgttag gttattcggt cttcgacagt 60
gataagttgg tagagaaggc tttggtatct catctgttgc tgagatcttt cagctccata 120
gcgaaacatt cttcagagat aatgagagtg aggtcctgac ggatctgtca tcaatgcac 180
ggttggttgt tgcaaccgga ggtggtgcag tgatccgacc aatcattgga g 231

<210> 175

<211> 241

<212> DNA

<213> Zea mays

<400> 175

gtcccactgg atgcacttgc aagaagaatc gctgctgtag gaaccgcgtc tcgaccactc 60
ttgcatcagg aatccggtga tccttatgca aaggcttatg caaaacttac gtcacttttt 120
gagcaaagaa tggactcgta tgctaattgct gatgccagag tttcacttga acatattgca 180
ttaaaacaag gccataatga tgtcactata cttacaccta gtaccatcgc cattgaggca 240
t 241

<210> 176

<211> 337

<212> DNA

<213> Zea mays

<223> unsure at all n locations

<400> 176

cctccatgcg acgattagtt gttgccaccg gaggtgtgct gttatccgac caattaactg 60
gagatatatg aagagggggc tatctgtttg gttagatgtg cccttggtatg ctcttgctag 120
gcgtattgct aaagtgggaa ctgcctctcg tcctcttctg gaccaaccat ctggtgatcc 180
gtacgcaatg gcctttttcta agctcagcat gcttgcacag caaaggggtg atgcttatgc 240
aaatgcagat gtaaggggtt ctctggaaga gattgcatgt anacaaggtc atgatgatgt 300
ctctaagctg acacctactg atattgcaat tgagtca 337

<210> 177

<211> 360

<212> DNA

<213> Zea mays

<400> 177

gaagggccta tccgttttgg tagatgtgcc cttggatgct cttgctaggg gcattgctaa 60
agtgggaacc gcttctcgtc ctcttctgga ccaaacgtcc ggtgatccat acacaatggc 120
cttttctaag ctcagcatgc ttgcagagca aaggggtgat gcttatgcaa atgcggatgt 180
aagggtttct ctggaagaga ttgcatctaa acaaggatcat ggcgatgtct ctaagctgat 240
gccgactgat atcgcaattg agtcacttca taagatcgag agtttctgca tcgagcacgc 300
tgctgataat ccagctagcg actcgcaagc tgagtcacag atccaaggat acagacttgt 360

<210> 178

<211> 460

<212> DNA

<213> Zea mays

<400> 178

agggtgtgag aatggctcat ggagcacggg cggatatcgg gtcagccccg cgtctgcgca 60
gaagtctgcc gacgcgtggg ggaacacgcc aatctatatt gttggtacgg attgcacagc 120
caagcgcaac atcgccaagc tgcttgcgaa ttccataata taccgctacc tcagcagtga 180
ggaactgctt gaggatgttc ttggtggcaa ggacgccttc agagccttca aggaatctga 240
tgagaacggg tatcttgaag tcgagacgga agggttaaag cagctcacgt ccatgggtag 300
ccttgtagtg tgctgtggag atggcgccgt tatgaactca accaatctag ggctgctgag 360
gcatgggtgc tccatttggg ttgatgttcc tcttgaaatg gcagcaaatg acatgttgaa 420
gagcactgga acacaagcta ctacagatcc agactctttt 460

<210> 179

<211> 434

<212> DNA

<213> Zea mays

<400> 179

aaggtccact actctgctga tgacgtcttc atactacagc aaaaagccca ggatgttctg 60
ccttacttgg atggccgttg cgtttatctt gttggaatga tgggttcagg caaaactaca 120
gttgggaaga tactatccga agtggttagg tattcgttct tcgacagtga taagttggta 180

gagaaggctg ttggtatttc atctgttgct gagatctttc agctccatag cgaaacattc 240
 ttcagagata atgagagtga ggtcctgagg gatctgtcat caatgcatcg gttggttggt 300
 gcaaccggag gtggtgcagt gatccgacca atcaattgga gttacatgaa gaaagggctg 360
 accgtatggt tagatgtccc actggatgca cttgcaagaa gaattgctgc ttaggaacc 420
 gcgtctcgac cact 434

<210> 180
 <211> 281
 <212> DNA
 <213> Glycine max
 <223> unsure at all n locations
 <400> 180

cttgttgnta atgatggcct ctgggaagac aactngggac gganattgtc agaggcgctt 60
 tcttattcgt tttannatag tgatgcattg gtggtgaagg aggttggtgg aatatctgta 120
 actgatatat tcaagcacta tggagagcct tttttcgtaa taaggagatn gaggtgttgc 180
 agaagggtgc aataatggca tagacatctt atttctactg gtggangtgc gtcgtgaggc 240
 ccatcattgg aaatatatgc agcaggggat tagtgtttgg t 281

<210> 181
 <211> 271
 <212> DNA
 <213> Glycine max
 <400> 181

ttcaagcact atggagagcc tttttttcgt aataaggaga ctgaggtggt gcagaagggtg 60
 tcaataatgc atagacatct tttttctact ggtggagggtg ctgtcgtgag gcccatcaat 120
 tggaaatata tgcagcaggg gattagtgtt tggttggtatg tacctgtaga agtcttgact 180
 cagagaataa cagctgaagg aactgattct cgcccacttc tacattatga aggaggagat 240
 gcatacacia agactatcac gcatttgtct t 271

<210> 182
 <211> 283
 <212> DNA
 <213> Glycine max
 <223> unsure at all n locations

<400> 182

cagtatcaga cggcaccgtt tcgtcttcgc ttggtgccac ggactcgtct cttgcggtga 60
agttttttgtt cagaagaaag cagcagaggt gtctttctgag ctcaaaggga cctccatatt 120
tctggttgggt ttgaagagct ctcttaaact agtttgggga agctgctggc tgatgcattg 180
cgggtattatt atttcgacag tgatagtttg gtggaagaag cngtaggtgg tgcactggct 240
gcaaaatcat tcagagagag tgacgaaaaa ggcttctatg agt 283

<210> 183

<211> 414

<212> DNA

<213> Glycine max

<400> 183

aatcgccctt ccaattttct tcaattcaag caccaaaact gcttcttgaa gttcccgaac 60
ccaaacctcc atcgactgcg caggetcaat tgctcagtat cagacggcac cgtttcgtct 120
tcgcttgggtg ccacggactc gtctcttgcg gtgaagaaga aagcagcaga ggtgtcttct 180
gagctcaaag ggacctccat atttctgggt gggttgaaga gctctcttaa aactagtttg 240
gggaagctgc tggtgatgc attgcggtat tattatttcg acagtgatag tttggtggaa 300
gaagctgtac gtggtgcact ggctgcaaaa tcattcagag agagtgcga aaaaggcttc 360
tatgagtctg agactgaagt actgaagcaa ttatcgttca tgggtcgact agtg 414

<210> 184

<211> 244

<212> DNA

<213> Glycine max

<400> 184

tgcttttgtt gaaggatgatg cttcaagtgc cagttacttc ctagctgggtg cagcagtaac 60
tggtgggact atcactgtta atggctgtgg cacaagcagt ttacagggag atgtaaaatt 120
tgctgaagtt cttgaaaaga tgggagctaa ggttacatgg tcagagaaca gtgtcaccgt 180
tactggaccg ccacaagatt cttctggtca aaaagtcttg caaggcattg atgtcaatat 240
gaac 244

<210> 185

<211> 262
 <212> DNA
 <213> Glycine max

 <400> 185

 ggtttctgca tcggtcgccg ccgcagagaa gccgtcaacg tcgccggaga tcgtgctgga 60
 acccatcaaa gacttctcgg gtaccatcac attgccaggg tccaagtctc tgtccaatcg 120
 aattttgctt cttgtgctc tccttgaggg aacaactggt gtagacaact tgttgtatag 180
 tgaggatatt cattacatgc ttggtgcatt aaggaccctt ggactgcgtg tggaagatga 240
 caaaacaacc aaacaagcaa tt 262

<210> 186
 <211> 234
 <212> DNA
 <213> Glycine max

 <400> 186

 tgctgtacag cgaggatatt cattacatgc ttggtgcatt aaggaccctt ggactgcgtg 60
 tggaagacga ccaaacaacc aaacaagcaa ttgtggaagg ctgtggggga ttgtttccca 120
 ctattaaaga atctaaagat gaaatcaatt tattccttgg aagtgcgtgt actgcgatgc 180
 gtcctttgac agcagctgta gttgctgcag gtggaaatgc aagctacgta cttg 234

<210> 187
 <211> 280
 <212> DNA
 <213> Glycine max

 <400> 187

 gttgggaacc tatcaaagac atctcgggta ccatcacatt gccagggctt aagtctctgt 60
 ccaatcgaat tttgcttctt gctgctctct ctgagggaac aactgttgta gacaacttgc 120
 tgtacagcga ggatattcat tacatgcttg gtgcattaag gacccttgga ctgcgtgtgg 180
 aagacgacca aacaacaaaa caagcaattg tggaaggctg tgggggattg tttcccacta 240
 ttaaagaatc taaagatgaa atcaatttat tccttgga 280

<210> 188
 <211> 239
 <212> DNA

<213> Glycine max
 <400> 188

cccacgcctt tggggggcct caaaatctcg catcccgatg cataaaaatg gaagctttat 60
 gggaaatddd aatgtgggga acggaaattc cggcgtgttt aaggtttctg catcggtcgc 120
 cgccgcagag aagccgtcaa cgtcgccgga gatcgtgttg gaacccatca aagacttctc 180
 gggatccatc acattgccag ggtccaagtc tctgtccaat cgaattttgc ttcttgctg 239

<210> 189
 <211> 256
 <212> DNA
 <213> Glycine max
 <400> 189

cagctcgggtg cagatgttga ttgttttctt ggcacaaact gtccacctgt tcgtgtaaat 60
 gggaaaggag gacttcctgg cggaaagggtg aaactgtctg gatcaattag cagtcaatac 120
 ctaactgctt tgcttatggc agtccttcta gctcttggcg acgtggaaat tgagattgtt 180
 gataaactga tttctgttcc atatgttgaa atgactctga agttgatgga gcgttttgga 240
 gtttctgtgg aacaca 256

<210> 190
 <211> 263
 <212> DNA
 <213> Glycine max
 <223> unsure at all n locations
 <400> 190

caggttcaaa ccggagcaaa aaaacttggt acgatgggtt cttccgacaa ggatccaccn 60
 ttgacancan ctgtggttgc tgcagggtga aatgcaagct acgtacttga tgggggtgcc 120
 cgaatgagag agaggccaat tggggatttg gttgctggtc ttaanccgtt atnactcaaa 180
 ccgagaccga aactgacgga gccaccatcg tcgacgtcgc cgtcgccgtc aacgtcaacg 240
 tcaacgtnaa cgacgagaat tac 263

<210> 191
 <211> 255
 <212> DNA
 <213> Glycine max

<400> 191

ctgcaatgcg tcctttgaca gcagctgtgg ttgctgcagg tggaaatgca agctacgtac 60
ttgatgggggt gccccgaatg agagagaggc caattgggga tttggttgct ggtcttaagc 120
aacttggtgc agatgttgat tgctttcttg gcacaaactg tccacctgtt cgtgtaaatg 180
ggaagggagg acttcctggc ggaaaggatg aactgtctgg atcagtttagc agtcaatact 240
tgactgcttt gctta 255

<210> 192

<211> 262

<212> DNA

<213> Glycine max

<400> 192

gcaatgcgctc ctttgacagc agctgtgggt gctgcagggtg gaaatgcaag ctacgtactt 60
gatgggggtgc cccgaatgag agagaggcca attggggatt tggtagctgg tcttaagcaa 120
cttggtgcag atgttgattg ctttcttggc acaaactgtc caoctgttcg tgtaaattggg 180
aagggaggac ttcttggcgg aaagggtgaaa ctgtctggat cagtttagcag tcaataacttg 240
actgctttgc ttatggcagc tc 262

<210> 193

<211> 260

<212> DNA

<213> Glycine max

<400> 193

gggagctaag gttacatggt cagagaacag tgtcactgtt tctggaccac cagagattt 60
ttctggctga aaagtcttgc gaggcattga tgtcaatatg aacaagatgc cagatgttgc 120
catgacactt gctgttggtg cactatcttg taatgggtccc actgctataa gagatgtggc 180
aagttggaga gttaaagaga ctgagaggat gatagcaatc tgcacagAAC tcagaaagct 240
aggagcaaca gttgaagaag 260

<210> 194

<211> 271

<212> DNA

<213> Glycine max

<400> 194

gggagctaag gttacatggt cagagaacag tgtcactggt tctggaccac cagagattt 60

ttctgggtcga aaagtcttgc gaggcattga tgtcaatatg aacaagatgc cagatgttac 120

catgacactt gctgttgttg actattttgct aatgggtocca ctgctataag agatgtggca 180

agttggagag ttaaagagac tgagaggatg atagcaatct gcacagaact cagaaagcta 240

ggagcaacag ttgaagaagg tcctgattac t 271

<210> 195

<211> 305

<212> DNA

<213> Glycine max

<223> unsure at all n locations

<400> 195

ctgattttctg ttccatatgt tganatgact ctgaagttga tggagcggtt tggagtttct 60

gtggaacaca gtggttaattg ggatagggtc ttggtccatg gaggtcaaaa gtacaagtct 120

cctggcaatg cttttgttga aggtgatgct tcaagtgccca ttatttacta gctggtgcag 180

caattactgg tgggactatc actgttaatg gctgtggcac aagcagttta cagggagatg 240

taaaatttgc tgaagttctt gaaaagatgg gagctaagggt tacatgggtca gagaacagtg 300

tcact 305

<210> 196

<211> 280

<212> DNA

<213> Glycine max

<223> unsure at all n locations

<400> 196

gaaattgaga ttgttgataa actgattttct gttccatatg ttgaaatgac tctgaagntg 60

atggagcggt ttngagtttc tgtggaacac agtggttaatt gggatagggt cttggtccat 120

ggaggtcana agtacaagtc tcctggnaat gcttttgttg aaggtgatgc ttcaagtgcn 180

agttattttac tanctgggtgc agcaantact gnnnggacta tcaactgttna tggctgtggc 240

acaaacagtt tacagggaga tgtaaaatth gcngnagttc 280

<210> 197
 <211> 280
 <212> DNA
 <213> Glycine max

 <400> 197

 gtttagcagtc aataacttgac tgcttttgctt atggcagctc ctttagctct tggatgatgtg 60
 gaaattgagc attgttgata aactgatacc tgttccatat gttgaacatg actctgaagt 120
 tgatggagcg ttttggagtt tctgtggaac acagtggtaa ttgggatagg ttcttgggtcc 180
 atggagggtca aaagtacaag tctcctggca atgcttttgt tgaaggatgat gcttcaagt 240
 ccagttcttt actagctggt gcagcaatta ctgggtgggat 280

<210> 198
 <211> 136
 <212> DNA
 <213> Glycine max

 <400> 198

 gttgaaatga ctctgaagtt gatggagcgt tttggagttt ctgtggaaca cagtcgtaat 60
 tgggataagt tcttgggtcca tggagggtcaa aagtacaagt ctctctggcaa tgcttttgtt 120
 gaaggatgatg cttcaa 136

<210> 199
 <211> 331
 <212> DNA
 <213> Zea mays

 <400> 199

 atcccagcct cggtcgtatc atcaactgca agctccggca tcccaggat ttgatcctat 60
 ctcttctaaa tagccgtgtt cctccatttt acgctcaccg atcatcaa atctctccaag 120
 ccatcatgtc gaccttcgga acactctttc gcgttactac ctacggtgaa tctcactgtg 180
 cctcggtcgg ctgcattgtc gacggcggtc ctccaggcct caaactcact gctcctgaca 240
 ttcaagtgca gcttagccgt cgacgacctg gtcagagcaa ttgaccact ccccgaaacg 300
 agaaggacct tgtcaacatc cagtccggag t 331

<210> 200
 <211> 305

<212> DNA
 <213> Zea mays

<400> 200

cttcattagc tcatccaatc tattccgatg acgaccgtgc ccacgccaca gcaggtggcg 60
 cactcacggg ctcggtcgc accccgcgcg atcgggcgct tgctggagtt tgccccagcc 120
 tctctctccc tccgcttcgc cgtgcaccgc tgcgcactg ctgcctaga ggtgaaggca 180
 tctggaaaca cgtttggaaa ctactttcag gttgcaacct atggtgaatc tcatgggggt 240
 ggtgttggtt gtgttatcag tggttgccac ctagaattca ctactgagg cagactacaa 300
 gttga 305

<210> 201
 <211> 303
 <212> DNA
 <213> Zea mays

<400> 201

cagcttcgtc tctctcgccg gcgcggcaac tatcatcact tcattagctc atccaatcta 60
 ttccgatgac gaccgtgcc acgccacagc aggtgggtac tcacgggcac ggctcgcacc 120
 ccgcgcgatc ggcgccttgc tggagtttgc cccagcctcc tctctcctcc gcttcgccgt 180
 gcaccgctgc cgcactgtc gcctagaggt gaaggcatct ggaaacacgt ttggaaacta 240
 ctttcagggt gcaacttatg gtgaatctca tgggggtggt gttggctgtg ttatcagtgg 300
 ttg 303

<210> 202
 <211> 285
 <212> DNA
 <213> Zea mays

<400> 202

ctcagcttcg tctctctcgc cggcgcggca actatcatca cttcattagc tcatccaatc 60
 tattccgatg acgaccgtgc tcacgccaca gcaggtggcg tactcacggg cacggctcgc 120
 accccgcgcg atcgggcgct tgctggagtt tgccccagcc tctctctccc tccgcttcgc 180
 cgtgcaccgc tgcgcactg ctgcctaga ggtgaaggca tctggaaaca cgtatggaaa 240
 ctactttcag gttgcaactt atggtgaatc tcatgggggt ggtgt 285

<210> 203
 <211> 302
 <212> DNA
 <213> Zea mays

<400> 203

gatgggatga ctactggtac accaattcac gtctttgtcc caaacacaga tcaaaggggt 60
 ggtgattaca gtgaaatgtc taaggcgtac agaccatccc atgcagatgc aacctatgac 120
 ttcaagtatg gagttagagc tgtgcaggga ggtggaaggt catcagccag agaaaccatt 180
 ggcagggtgg ctgcaggagc tcttgcaaag aaaattctaa agctcaaadc aggagtggag 240
 atcttggcat ttgtttctaa agtgcaccaa gtcgtacttc cagaagatgc agttgattat 300
 ga 302

<210> 204
 <211> 304
 <212> DNA
 <213> Zea mays

<400> 204

cggaccgtgg ggcgagggtg aaggtcatca gccagagaaa ccattggcag ggtggctgca 60
 ggagctcttg caaagaaaat tctaaagctc aaatcatcag tggagatctt ggcatttggt 120
 tctaaagtgc accaagtcgt acttccagaa gatgcagttg attatgagac tgtaaccttg 180
 gaacatatag agagcaacat cgttagatgt cctgatccag aatatgcaga gaagatgatt 240
 gctgccattg atacggtacg agttagagga gattcaattg gtggggctcg cacatgcatt 300
 gcaa 304

<210> 205
 <211> 301
 <212> DNA
 <213> Zea mays

<400> 205

tggagatctt ggcatttggt tctaaagtgc accaagtcgt acttccagaa gatgcagttg 60
 attatgagac tgtaaccttg gaacatatag agagcaacat cgttagatgt cctgatccag 120
 aatatgcaga gaagatgatt gctgccattg atacggtacg agttagagga gattcaattg 180

gtgggggtcgt cacatgcatt gcaagaaatg ttctctgtgg tcttggtctt cctgtttttg 240
 acaaaacttga agctgaactg gctaaagcca tgctttctct tcctgcaagc aaggggggtg 300
 a 301

<210> 206
 <211> 334
 <212> DNA
 <213> Zea mays

<400> 206

caataagctc gagctcgagc cgctcgagcc gtgcagatgc aacctatgac ttcaagtatg 60
 gagttagagc tgtagcaggg agacggaagg tcctcagcca gagaaaccat tggcaggggtg 120
 gctgcaggag ctcttgcaaa gaaaattcta aagctcaaat caggagtgga gatcttggca 180
 tttgtttcta aagtgcacca agtcgtactt ccagaagatg cagttgatta tgagactgta 240
 accttggaac atatagagag caacatcggt agatgtcctg atccagaata tgcagagaag 300
 atgattgctg ccattgatac ggtacgagtt agag 334

<210> 207
 <211> 301
 <212> DNA
 <213> Zea mays

<400> 207

cggaacgctg gatcaggaaa tgtgttcggg aactacttcc aggttgcaac ctatggcgaa 60
 tcccatggag ggggtgttgg ttgcgttatt agtggctgcc caccagaat tcctctcact 120
 gaggcagaca tgcaagtaga actcgataga agacgtccgg gtcaaagtag aattacaacc 180
 ccaagaaagg agactgatac atgcaaaatt ctatcaggga cacatgatgg gatgactact 240
 ggtacaccaa ttcacgtctt tgtcccaaac acagatcaaa ggggtggtga ttacagtga 300
 a 301

<210> 208
 <211> 254
 <212> DNA
 <213> Zea mays

<400> 208

cacacgcacg cggtagaatt acaaccccaa gaaaggagac tgatacatgc aaaattctat 60
cagggacaca tgatgggatg actactggta caccaattca cgtctttgtc ccaaacacag 120
atcaaagggg ttgtgattac agtgaaatgt ctaaggcgta cagaccatcc catgcagatg 180
caacctatga cttcaagtat ggagttagag ctgtgcaggg aggtggaagg tcatcagcca 240
gagaaaccat tggc 254

<210> 209
<211> 232
<212> DNA
<213> Zea mays

<400> 209

ctaaagctca aatcaggagt ggagatcttg gcatttgttt ctaaagtgc ccaagtcgta 60
cttcagaag atgcagttga ttatgagact gtaaccttgg aacatataga gagcaacatc 120
gttagatgtc ctgatccaga atatgcagag aagatgattg ctgccattga tacggtacga 180
gttagaggag attcaattgg tggggtcgtc acatgcattg caagaaatgt tc 232

<210> 210
<211> 277
<212> DNA
<213> Zea mays

<400> 210

cttcagggtt gcaacctatg gcgaatccat ggaggggggtg ttggttgcgt tatcagtggc 60
tgcccacca gaattcctct cactgaggca gacatgcaag tagaactcga tagaagacgt 120
ccgggtcaaa gtagaattac aacccaaga aaggagactg atacatgcaa aattctatca 180
gggacacatg atgggatgac tactggtaca ccagttcacg tctttgtccc aaacacagat 240
caaaggggtg gtgattacag tgaaatgtct aaagcgt 277

<210> 211
<211> 196
<212> DNA
<213> Zea mays

<400> 211

cactcgatag aagacgtccg ggtcaaagta gaattacaac ccaagaaag gagactgata 60

catgcaaaat tctatcaggg acacatgatg ggatgactac tggtacacca attcacgtct 120
 ttgtcccaaa cacagatcaa aggggtggtg attacagtga aatgtctaag gcgtacagac 180
 catcccatgc agatgc 196

<210> 212
 <211> 309
 <212> DNA
 <213> Zea mays

<400> 212

ggcaacaaaa ctttctccga tggccgcgcc cgtgtcgcag ccgccggtgt ccgccagggc 60
 gtccacacgg ttttcccccc gcgggatagg cgcgtcccg gagtccgctc ccacgtccct 120
 ccggttatcc gtcggccgcc gtcgccgggc cgcagccta gaggtgaagg catcgggaaa 180
 tgtgttcggg aactacttcc aggttgcaac ctatggcgaa tcccatggag ggggtgttgg 240
 ttgcgttatc agtggctgcc caccagaat tcctctcact gaggcagaca tgcaagtaga 300
 actcgatag 309

<210> 213
 <211> 285
 <212> DNA
 <213> Zea mays

<400> 213

ctttctccga tggccgcgcc cgtgtcgcag ccgccggtgt acgacagggc gtccacacag 60
 ttttcccccc gcgggatagg cgcgtcccg gagtccgctc ccacgtccct ccggttatcc 120
 gtcggacgcc gtcgccgggc cgcagcata gatgtgaagg catcgggaaa tgtgttcggg 180
 aactacttcc aggttgcaac ctatggcgaa tcccatggag ggggtgttgg ttgcgttatc 240
 agtggctgcc caccagaat tcctctcact gaggcagaca tgcaa 285

<210> 214
 <211> 317
 <212> DNA
 <213> Zea mays

<400> 214

ctcagaccct caccaaccag gcaacaaaac ctttctccgat ggccgcgccc gtgtcgcagc 60

cgccggtgtc cgccagggcg tccacacggt ttctcccccg cgggataggc gcgctcccgg 120
 agtccgctcc cacgtccctc cggttatccg tcggccgccc tcgccgggcc gccagcctag 180
 aggtgaaggc atcgggaaat gtgttcggga actacttcca ggttgcaacc tatggcgaat 240
 ctcatggagg ggggtgttggg tgcgttatca gtggctgccc acccagaatt cctctcactg 300
 aggcagacat gcaagta 317

<210> 215
 <211> 286
 <212> DNA
 <213> Zea mays

<400> 215

ggacctgggc tcagaccctc accaaccagg caaccaaacc ttctccgatg gccgcgcccc 60
 tgtcgcagcc gccggtgtcc gccaggactt ccacacggtt tctcccccg cgggataggcg 120
 cgctcccgga gtccgcccc acgtccctcc ggttatccgt cggccgcccgt cgcgcgcct 180
 ccagcctaga ggtgaaggca tcaggaaatg tggtcgggaa ctacttccag gttgcaacct 240
 atggcgaatc ccatggaggg ggtgttgggt gcgttatcag tggctg 286

<210> 216
 <211> 274
 <212> DNA
 <213> Zea mays

<400> 216

ctcagaccct caccaaccag gcaaccaaacc cttctccgat ggccgcgccc gtgtcgcagc 60
 cgccggtgtc cgccagggcg tccacacggt ttctcccccg cgggataggc gcgctcccgg 120
 agtccgcccc cacgtccctc cggttatccg tcggccgccc tcgccgcgcc tccagcctag 180
 aggtgaaggc atcaggaaat gtgttcggga actacttcca ggttgcaacc tatggcgaat 240
 cccatggagg ggggtgttggg tgcgttatca gtgg 274

<210> 217
 <211> 255
 <212> DNA
 <213> Zea mays

<400> 217

ggcaacaaaa ctttctccga tggccgogcc cgtgtcgcag ccgccggtgt ccgccagggc 60
gtccacacgg tttctcccc gcgggatagg cgcgctcccg gagtccgctc ccacgtccct 120
ccggttatcc gtcggccgcc gtcgcccggc cgcagccta gaggtgaagg catcgggaaa 180
tgtgttcggg aactacttcc aggttgcaac ctatggcgaa tcccatggag ttggtgttgg 240
ttgcggtatc agtgg 255

<210> 218
<211> 299
<212> DNA
<213> Zea mays

<400> 218

ctgtttttga caaacttgaa gctgaaotgg caaaagccat gctttctctt cctgcaagca 60
aggggtttga gattggcagt gggttcogtg gtacggactt tactggaagt gagcataatg 120
atgagttcta tatggatgag gctggaaatg tgaggacacg aactaatcgc tcaggcgggtg 180
ttcaggggagg gatatcaaat ggtgaaatta tttacttcaa agtggctttt aagccaacag 240
caactatcgg aaagaagcaa aatactgtgt caaggagca tgaggatgtt gaacttttg 299

<210> 219
<211> 310
<212> DNA
<213> Zea mays

<400> 219

acataatgat gagttctata tggatgaggc tggaaatgtg aggacacgaa ctaatcgctc 60
aggcgggtgt caggggagga tatcaaattg tgaaattatt tacttcaaag tggcttttaa 120
gccaacagca actatcggaa agaagcaaaa tactgtgtca agggagcatg aggatgttga 180
acttttggca agggggcgcc atgaccctg tgttgtccct cgagctgttc ctatggtggt 240
atccatggct gctctggtcc tgatggacca gctcatggcg catattgcc agtgtgagat 300
gtttccgctg 310

<210> 220
<211> 267
<212> DNA
<213> Zea mays

<400> 220

acggacttta ctggaagtga gcataatgat gagttctata tggatgaggc tggaaatgtg 60
aggacacgaa ctaatcgctc aggcggtggt cagggaggga tatcaaattg tgaaattatt 120
tacttcaaag tggcttttaa gccaacagca actatcgga agaagcaaaa tactgtgtca 180
agggagcatg aggatgttga acttttggca agggggcgcc atgaccctg tgttgtccct 240
cgagctgttc ctatggtgga atccatg 267

<210> 221

<211> 241

<212> DNA

<213> Zea mays

<400> 221

gtttgagatt ggcagtgggt tcgctggtac ggactttact ggaagtgagc ataatgatga 60
gttctatatg gatgaggctg gaaatgtgag gacacgaact aatcgctcag gcggtgttca 120
gggagggata tcaaatggtg aaattattta cttcaaagt gcttttaagc caacagcaac 180
tatcggaag aagcaaaata ctgtgtcaag ggagcatgag gtgttgaact tttggcaagg 240
g 241

<210> 222

<211> 231

<212> DNA

<213> Zea mays

<400> 222

ggctggaaat gtgaggacac gaactaatcg ctcaggcgggt gttcaggag ggatatcaaa 60
tggtgaaatt atttacttca aagtggcttt taagccaaca gcaactatcg gaaagaagca 120
aaatactgtg tcaagggagc atgaggatgt tgaacttttg gcaagggggc gccatgaccc 180
ctgtgttgtc cctcgaggta atgtctccaa aaatttccta ctttttatca t 231

<210> 223

<211> 241

<212> DNA

<213> Zea mays

<400> 223

caacagcaac tatcggaag aagcaaaata ctgtgtcaag ggagcatgag gatgttgaac 60
 ttttggcaag ggggcgccat gacccctgtg ttgtccctcg agctgttcct atggtggaat 120
 ccatggctgc gctggctctg atggaccact catggcgcat attgccagc gtgagatgtt 180
 tccgctgaac cttgccctac aagagcccat tggctctgct agcagtgcac ctgaactgtc 240
 a 241

<210> 224
 <211> 218
 <212> DNA
 <213> Zea mays
 <400> 224

cccctgtgtt gtccctcgag ctgttctat ggtggaatcc atggctgcac tggctctgat 60
 ggaccagctc atggcgcata ttgccagtg tgagatgttt ccgctgaacc ttgccctaca 120
 agagcccatt ggctctgcta gcagtgcac tgaactgtca ccaaactat cataatgttt 180
 gtcgtggaac atgtcccagc tttccttoga ccgaaatt 218

<210> 225
 <211> 282
 <212> DNA
 <213> Zea mays
 <400> 225

ctgtttttta ttctattact tctgtagctg ttctatggt ggaatccatg gctgctttgg 60
 tcctgatgga ccagctcatg gcgcatttg cccagtgtga gatgtttccg ctgaaccttg 120
 ccctacaaga gccattggc tctgctagca gtgcatttga actgtcacca aacctatcat 180
 aatgactgtc gtggaacatg tcccagcttt cttctatcg aaattctggt ctttgctaag 240
 cagtttgcaa ttcggaacct ccataaaccc tcgactattg ta 282

<210> 226
 <211> 397
 <212> DNA
 <213> Zea mays
 <400> 226

acggacgcgt gggatatgaa tggtagatt gtgcacttca aagttgcttt taagccgaca 60

ccatctatcg ggggtgaaaca gaacactgtg tcaagggagc gtcagaacgt tgagcttctg 120
gcaagagggc gccatgaccc atgcgtcgcc cctcgagctg ttctgtggt ggaatccatg 180
gccgcgttgg tcctcgtgga ccagctgatg gcgcacgtgg ccagtgcca gatgttcgcg 240
ctcaatgctg cacttcaaga accagttggc tctttctagc agaggcagag cacacctgat 300
gagctcgcgc caaatTTTTat catTTatcat agtaataagt agtcaagcg tggcttggtt 360
tgcttgcttc ttgcaccgta gttttgtttt ttttccc 397

<210> 227
<211> 420
<212> DNA
<213> Zea mays

<400> 227

aggggtgact actggcacgc caattgttgg tattgtccca aacacagatc agataggcag 60
tgatcacctg gaaatagcca atgtgtaccg accttctcat gcagacgcaa cttatgactt 120
caagtacggc gttagagctg tacagggagg tgggaggctg tttggcacag aaaccgtagg 180
aaggggtggct gcagggtccc tcgccaagaa aattcttaag ctcaaagtgt gattagagat 240
ctcgtcgttt gtttacaag tgcatcacgt tgtgtccca gaagacgcgg ttgattatgg 300
atctgtaact ttggaacata tagagagcaa catcgttaga tgtgctgac cagagtacgc 360
agagatgatt atagacgcaa tcgacagagt tcgagttcca agggattcgg acggtggaat 420

<210> 228
<211> 406
<212> DNA
<213> Zea mays

<400> 228

aaaggggtgg tgattacagt gaaatgtcta aggcgtacag accattccat gcagatgcaa 60
cggatgactt caagtatgga gttagagctg tgcattggagg tggaaggcca tcagccagag 120
aaaccattgg caggggtggct gcaggagctc ttgcaaagaa aattctaaag ctcaaatacag 180
gagtggagat cttggcattt gtttctaaag tgcaccaagt cgtactttca gaagatgcag 240
ttgattatga gactgtaacc ttggaacata tagagagcaa catcgttaga tgtcctgac 300
cataatatgc acagaagatg attgctgcca ttgatacggg acgagttata ggagattcaa 360

ttggtggggt cgtcacatgc attgcaagaa atgttcctcg tgggtct 406

<210> 229
 <211> 453
 <212> DNA
 <213> Zea mays

<223> unsure at all n locations
 <400> 229

cccacgcgtc cgagtgaaat gtctaagggtg tacagaccat cccatgcaga tgcaacctgt 60
 gacttcaagt atggagttag agctgtgcag ggaggtggaa ggtcatcagc cagagaaacc 120
 attggcaggg tggctgcagg agctcttgca aagaaaattc taaagctcaa atcaggagtg 180
 gagatcttgg catttgtttc taaagtgcac caagtcgtac ttccagaaga tgcagttgat 240
 tatgagactg taaccttggga acatatagag agcaacatcg ttagatgtcc tgatccagaa 300
 tatgcagaga agatgattgc tgccattgat acgggtacgag ttagaggaga ttcaattggg 360
 ggggtcgtca catgcattgc angaaatggt cctcgtgggc ttggctctcc tgtttttgac 420
 aaacttgaag ctgaactggg caaagccatg ctt 453

<210> 230
 <211> 385
 <212> DNA
 <213> Zea mays

<400> 230

agaccatccc atgcagatgc aacctatgac ttcaagtatg gagttagagc tgtgcaggga 60
 ggtggaaggt catcagccag agaaaccatt ggcaggggtg ctgcaggagc tcttgcaaag 120
 aaaattctaa agctcaaata acgagtggag atcttggcat ttgtttctaa agtgcaccaa 180
 gtcgtacttc cagaagatgc agttgattat gagactgtaa ccttggaaca tatagagagc 240
 aacatcctta gatgtcctga tccagaatat gcagagaaga tgattgctgc cattgatacc 300
 gtacgagtta gaggagattc aattgggtggg gtcgtcacat gcattggaag aaatgttcct 360
 cgtggtcgtg gatccccctgt ttttg 385

<210> 231
 <211> 400
 <212> DNA

<213> Zea mays
 <400> 231

aggatgttga acttttggca agggggcgcc atgaccctg tgttgtccct cgagctgttc 60
 ctatggtgga atccatggct gcgctggtcc tgatggacca gctcatggcg catattgccc 120
 agtgtgagat gtttccgctg aaccttgccc tacaagagcc cattggctct gctagcagt 180
 catctgaact gtcaccaaac ctatcataat gtttgtcgtg gaacatgttc cagctttcct 240
 tctatcgaaa ttctggtctt tgctaagcag tttgcaattc ggaaccccca taaaccctcg 300
 actattgtac ctatagataa agtgaacgga tatcatgata gaaatgcatt tatgtttttg 360
 tgatgtggtg ttttactggt attttaacccc tttttttttt 400

<210> 232
 <211> 245
 <212> DNA
 <213> Glycine max
 <223> unsure at all n locations
 <400> 232

ttctcttcca atggcgtctt ctctttccac ccaaccttcg actctagacg ctctctccgn 60
 ctctgcttct ctcaattcgc atctctcacc cctccacccc gctacctcc gactctcact 120
 ccgtcctcgt ctccccaaga gacttcacat acaggcgggt gggagtacct atggaaatca 180
 ctttcgtggt acaacatatg gggaatcaca tggaggagggt gttggttggt ttattgatgg 240
 atgtc 245

<210> 233
 <211> 254
 <212> DNA
 <213> Glycine max
 <400> 233

atttgacaaa cttgaagctg aactagctaa agctgctatg tcattgcctg caaccaaggg 60
 ctttcagttt ggtagtgggt atgcaggcac ctttttgact gggagtgaac acaatgatga 120
 gttctatata gatgaacatg gaaacacaag aacaagaaca aatcgctctg gtgggataca 180
 ggggtggaatt tccaatgggg aatcatttaa tatgagaata gctttcaggc caacatcaac 240
 aattggaaag aagc 254

<210> 234
 <211> 247
 <212> DNA
 <213> Glycine max

 <400> 234

 ccggttcaaa acgaggaaat tctagccaag aagtatagga ttcggttaag ggggaattgat 60
 gcaccagaaa gtgcaatgcc atatggaaag gaagctaaaa ctgaactgac caagattggt 120
 caaggcaagc ctttgaggat ccttggttat gaggaagatc gttatggtcg ttctgtaggt 180
 gatatctatt gtaatggcat tttgtacag gaaatgatgt taaagaaagg tttagcatgg 240
 cactacg 247

<210> 235
 <211> 255
 <212> DNA
 <213> Glycine max

 <223> unsure at all n locations
 <400> 235

 gtaccaata ctgatcaaag aggacatgac tatagcgaga tggcagtagc ttataggcct 60
 cccatgcaga tgctacctat gacatgaagt atgggtgtcag atcagttcag ggtgggtggt 120
 gatcttctgc aagagaaaaca attggnaggg ttgcttctgg tgctgttgct aagaaaatcc 180
 ttaaagaatt ttctggaact gagattctgg cctatgtctc tcaagttcat aagattgttc 240
 ttccagagga cctga 255

<210> 236
 <211> 249
 <212> DNA
 <213> Glycine max

 <400> 236

 actcgagccg attcggtcgc agggccttagt gaaattatta taggcacctt tttgactggg 60
 agtgcccaca atgatgagtt ctaaatagat gaacatggaa aactagaac aagaacaaat 120
 cgctctgtgg gatacaggta tttgtgctgt tctgtaatta ctaattagtt gtttctagat 180
 atgcactata tcagtcacat gtctatattt gtcttactta tattatctgt attgacaatc 240

aggggtggaa

249

<210> 237
<211> 201
<212> DNA
<213> Glycine max

<400> 237

gcactttatg actgggagtg aacacaatga tgagttctat atagatgaac atggaaacac 60
aagaacaaga acaaatcgct ctcgtgggat acaggggtgga atttccaatg gggaaatcat 120
taatatagaa tagctttcaa gccaacatca acaattggat taagtcttaa tctctttctct 180
ttctgtcttc atcactatct c 201

<210> 238
<211> 274
<212> DNA
<213> Glycine max

<400> 238

tctctcccaa tttctctcat caaagtttca acctttgata agattgaatc atggggaacg 60
ccctgagatt cctctacagc cattgctgca agcccacagc agctgggtgat tctgaatcac 120
ttggaccaca cggtgtttcc tctgccaccg ttgggtgtttc aacacttgcc catgatctct 180
ttcactttga catcacctcc cagggtcccg aaggactcag caagcatgtt gtgtcttcta 240
agaaggctca ggctaattgg tatagaaagt tagt 274

<210> 239
<211> 270
<212> DNA
<213> Glycine max

<400> 239

catttctctc atcaaagttt caacctttga taagattgaa tcatggggaa cgccctgaga 60
ttcctctaca gccattgctg caagcccaca gcagctgggtg attctgaatc acttggccca 120
cacgggtgtt cctctgccac cggttggtgtt tcaacacttg cccatgatct ctttcacttt 180
gacatcacct cccagggtccc ggaaggactc agcaagcatg ttgtgtcttc taagaaggct 240
caggctaatt ggtatagaga gtttagtagtg 270

<210> 240
 <211> 254
 <212> DNA
 <213> Glycine max

 <400> 240

 aatgttttta ggtcccgga ggactcagca agcatgttgt gtcttctaag aaggctcagg 60
 ctaattggta tagaaagtta gtagatgott ggaaagagggc aaaacctcct cctaagacac 120
 ctgaagaagc agctagactt gtcattcaga ccttgagaag acatcaaaaa gcagatgttg 180
 agggattgtt ggctttctat ggtcttcctc taccacacac actgggttcaa ggaactaccc 240
 aacccttttc atcc 254

<210> 241
 <211> 276
 <212> DNA
 <213> Glycine max

 <223> unsure at all n locations
 <400> 241

 atcacctccc aggtcccgga aggactcagc aagcatgttg tgtcttctaa gaaggctcag 60
 gctaattggt atagaaaagtt agtagatgct tggaaagagg caaaacctcc tcctaagaca 120
 cctgaagaag cagctagact tgtcattcag accttgagaa gacatgcaaa aagcagatgt 180
 tgagggattg ttggctttct atggtctcct ctaccacaca cactgggttca aggaataccc 240
 aacccttttc atccttgctt gatggaggtt anttga 276

<210> 242
 <211> 337
 <212> DNA
 <213> Glycine max

 <400> 242

 tcggaatcgg tcgtagaatt tctggaactg agattctggc ctatgtctct caagttcata 60
 agattgttct tccagaggac cttattgatc atgacactct gactcttgat cagattgaga 120
 gtaacattgt tcgatgtcca gaccggaggt atgcagagaa gatgatctct gcaattgatg 180
 ctgtgcgagt gagaggtgat tctgttggtg gtgttggtgac atgcattgtg aggaactgtc 240
 cacgaggtct cggttcacca gtatttgaca aacttgaagc tgagctggct aaagctgcaa 300

tgtcattgcc tgcaaccaag ggctttcagt ttggttag 337

<210> 243
 <211> 256
 <212> DNA
 <213> Glycine max

<400> 243

tgatcatgac actctgactc ttgatcagat tgagagtaac attgttcgat gtccagaccc 60
 ggagtatgca gagaagatga tatctgcaat tgatgctgtg cgagtgagag gtgattctgt 120
 tgggtggtgtt gtgacatgca ttgtgaggaa ctgtccacga ggtctcgggt caccagtatt 180
 tgacaaactt gaagctgagc tggttaaagc tgcaatgtca ttgcctgcaa ccaagggctt 240
 tcagtttgggt agtggg 256

<210> 244
 <211> 357
 <212> DNA
 <213> Glycine max

<223> unsure at all n locations
 <400> 244

gagacttcag atacgggctg ctgggagnnt ctatggaaat cactttcgtg tttcaacata 60
 tggncgaatc acatggagga ggtgttggtt gtattattga tggatgtcct cctcaccttc 120
 ctctctccga agctgatatg caattggatc ttgacagaag gaggccaggt cagagccgaa 180
 ttacaactcc tagaaaggag actgatacat gtaaaatatt ttcaggagtt tctgaaggac 240
 ttactactgg aactccaatt catgtatttg taccatact gatcaaagag gacatgacta 300
 tactgagatg gcagtagctt ataggccttc ccatgcagat ntactatgac atgagta 357

<210> 245
 <211> 252
 <212> DNA
 <213> Glycine max

<400> 245

ctgaagctga tatgcaagtg gatcttgaca gaaggaggcc aggtcagagc cgaattacaa 60
 ctcctagaaa ggagactgat acatgtaaaa tattttcagg agtttccgac agaataccta 120

ctggaactca attcatgtat ctgtacccaa tactgatcaa agaggacatg actatagcga 180
 gatggcagta gcttataggc cctcccatgc agatgctacc tatgacatga agtatggtgt 240
 cagatcagtt ca 252

<210> 246
 <211> 265
 <212> DNA
 <213> Glycine max

<400> 246

ggaaatcact ttctgtgttac aacatatggg gaatcacatg gaggaggtgt tggttgtgtt 60
 attgatggat gtccctctcg ccttccctctc tctgaagctg atatgcaagt ggatcttgac 120
 agaaggaggc caggctcagag ccgaattaca actcctagaa aggagactga tacatgtaaa 180
 atattttcag gagtttccga agaataccta ctggaactcc aattcatgta tctgtaccca 240
 atactgatca aagaggacat gacta 265

<210> 247
 <211> 181
 <212> DNA
 <213> Glycine max

<223> unsure at all n locations
 <400> 247

agagacttca gatacgggct gctgggagta tctatggaaa tcactttcgt gtttcaacat 60
 atggagaatc acatggagga ggtgttggtt gtattattga tgnatgtcct cctcaccttc 120
 ctctctccga agctgatatg caattggatc ttgacagaag gaggccaggt caganccgaa 180
 t 181

<210> 248
 <211> 274
 <212> DNA
 <213> Glycine max

<223> unsure at all n locations
 <400> 248

ctctttccac caaaccattc acacccgncg ctctctccgg ctctgcttct ctcaattccg 60
 atctcggacc cctctccccc gctacctcc gactctcact ccgtcctcgt cttcccaaga 120

gacttcacat acaggcggct gggagtagct atggaaatca ctttcgtgtt acaacatatg 180
 gggaatcaca tggaggagggt gttggttggt ttattgatgg atgtcctcct cgccttcctc 240
 tctctgaagc tgatatgcaa gtggatcttg acag 274

<210> 249
 <211> 248
 <212> DNA
 <213> Glycine max

<400> 249

gacgctctct ccgccttcgc ttctctcaat ccgatctcc gatccttctc ccccggtac 60
 ctccgtctct cactccgtcc togtcttccc aagatacttc agatacgggc ttctgggagt 120
 atctatggaa atcactttcg tgtttcaaca tatggagaat cgcattggagg aggtgttggt 180
 tgtattattg atggatgtcc tctctacott cctctctccg aagctgatat gcaattggat 240
 cttgacag 248

<210> 250
 <211> 302
 <212> DNA
 <213> Glycine max

<223> unsure at all n locations
 <400> 250

tctaattctc ccatttctct tccaatggcg tcttctcttt ccaccaaac attctacanc 60
 cgacgctctc tcgccttcg cttctctcaa ttccgatctc ggatccctct ccccgcta 120
 cctccgactc tcaactcgtc ctgctcttcc caagaacttc gcatacaggc ggctgggagt 180
 acctatggaa atcactttcg tgttacaaca tatggggaat cacatggagg aggtgttggt 240
 tgtgttattg atggagtctc ctgccttct tctctctgaa gctgatatgc aagtgganct 300
 tc 302

<210> 251
 <211> 246
 <212> DNA
 <213> Glycine max

<400> 251

ctccacaaa ccattctcat caaccgacgc tctctccgcc ttcgttctc tcaatcccgga 60

tctccgatcc ttctcccccg gctacctcog tctctcactc cgtcctcgtc ttcccaagag 120
 acttcagata cgggctgctg ggagtatcta tggaaatcac tttcgtgttt caacatatgg 180
 agaatcgcat ggaggagggtg ttggttgtat tattgatgga tgtcctcctc accttcctc 240
 tccgaa 246

<210> 252
 <211> 275
 <212> DNA
 <213> Glycine max

<400> 252

gttcctcaat caatctaatt ctcccatttc tcttccaatg gcgctcttctc tttccaccaa 60
 accattctca tccgacgctc tctccgcott cgtttctctc aattccgatc tcggatccct 120
 ctcccccgcc tacctccgac tctcactcog tctcgtctct cccaagagac ttcacataca 180
 ggcggctggg agtacctatg gaaatcaott tctgtgttaca acatatgggg aatcacatgg 240
 aggagggtgtt ggttgtgtta ttgatggatg tctc 275

<210> 253
 <211> 262
 <212> DNA
 <213> Glycine max

<400> 253

gcgcttcttct ctctccacca aaccattctc atcaaccgac gctctctcog ccttcgcttc 60
 tctccttccc gatctccgat ccttctcccc cggctacctc cgtctctcac tccgtcctcg 120
 tcttcccaag agacttcaga tacgggctgc tgggagtatc tatggaaatc actttcgtgt 180
 ttcaacatat ggagaatcca tggaggagggt gttggttgta ttattgatgg atgtcctcct 240
 caccttcctc tctccggagc tg 262

<210> 254
 <211> 263
 <212> DNA
 <213> Glycine max

<223> unsure at all n locations
 <400> 254

agatactgtg agtgtttttt ttctcaatc aatctaattc tctcaatggc ttcttctctc 60
tccaccaaac cattctcadc aaccgacgct ctctccgcct tcgcttctct caatcccgat 120
ctccgatcct tctcccccggt ctacctcgt ctctcactcc gtcctcgtct tcccaagaga 180
cttcagatac gggctgctgg gagtatctat ggaaatcact ttcgtgtttc aacatatgga 240
gaatcgcatg gaggagggtg tgg 263

<210> 255
<211> 374
<212> DNA
<213> Glycine max

<400> 255

tctctttcca ccaaaccatt ctcagcgcac gctctctccg ccttcgcttc tctcaattcc 60
gatctcggat cctctctccc cgcctacotc cgactctcac tccgtcctcg tcttcccaag 120
agacttcgca tacaggcggc tgggagtacc tatggaaatc actttcgtgt tacaacatat 180
ggggaatcac atggaggagg tgttggttgt gttattgatg gatgtcctcc tcgccttcct 240
ctctctgaag ctgatatgca agtggatott gacagaagga ggccagggtca gagccgaatt 300
acaactccta gaaaggagac tgatacatgt aaaatatttt caggagtttc cgaaggaatc 360
actactggaa ctcc 374

<210> 256
<211> 222
<212> DNA
<213> Zea mays

<400> 256

cttttggaga gaggacagtt ttgttacaat gctgatacat atgatagcaa tgctttccac 60
atggatgggt ttggcggctc tttggttgaa tatatggtta gagaaactga aaagctccat 120
gcacatgttg ggagatacaa gagccagatg agcacctttc tttccgagga tctgcctgag 180
cccgttgca gctatgatac caagggttgc accatgcgat ct 222

<210> 257
<211> 267
<212> DNA
<213> Zea mays

<400> 257

gtacccgctc aaccggccgg cctacgaccc cctccactcc gccgccggcc gccgcctcaa 60

cgccctctttc gtcgagctct tcatccgcga gtccgaggcc gttcagtcca aggccggaag 120

gtaccaaagc ctacaggaga ttccattctt cgcttacaga gttccttctg ctctggcgcc 180

tccatacaac ttcacaagcg atctgtatcc cgctgccgcy tcagtcaacg ttaacgacgc 240

catatggagc atgtacttcg acgagct 267

<210> 258

<211> 346

<212> DNA

<213> Zea mays

<400> 258

ccggcatttt ccttgcacaa cgtgctctcc ctcccatttc ctgcgaggtg gttggtagcg 60

atggccttca agctgatcac caagcccgcy gccggcgtcg ccgctgctgc ttactgggga 120

gatctcgccc aacaactccg caacgcccat agctaaggta gagaggggtg atcgaagtga 180

catattgaca ttggatagca tcagacaagt tttgattaga ctagaagaca gcatcatatt 240

tggccttttg gagagagcac agttttgtta caatgctgat acatatgata gcaatgcctt 300

tcacatggat ggttttggag gatctttggc ctgatataata gttaga 346

<210> 259

<211> 258

<212> DNA

<213> Zea mays

<400> 259

gttgggagat acaagagccc agatgagcac cttttctttt ccaaggatct gcctgagccc 60

cggttgccac ctatgcaata cccaaggggt ttgcatccca ttgctgattc tatcaatatc 120

aacaaagaga tttggaaaat gtattttgat gaacttcttc caagattggc gaaagaagga 180

agtgatggta atgctggatc cagtgcctct tgtgacacaa cctgcttgca ggcactctcc 240

agaaggatcc actatggg 258

<210> 260

<211> 254

<212> DNA

<213> Zea mays
 <400> 260
 ctatgggaag tttgtggcag aggctaagtt tcaggagtcc ccggaagctt acatgccagc 60
 cataatagct caggaccgtg atcaactcat gcaccttctc acatatgaaa cggtaggagcg 120
 tgctatcgaa catagggtgg aagccaaagc caagatcttc gggcaagagg tgaacatcgg 180
 tgtggaggac aacggcagcc caccggtgta caagatcggt ccgagcttgg tcgccgagct 240
 gtacagctac agaa 254

<210> 261
 <211> 216
 <212> DNA
 <213> Zea mays

<400> 261
 accgtgatca actcatgcgc cttctcacat atgaaacggg ggagcgtgct gtcgaacaca 60
 ggggtggaagc caaagccaag atcttcgggc aagaggtgaa cattggtgct aaggacaacg 120
 gcagccaacc agtctacaaa atcaggccga gcttggtcgc cgagctgtac agctacagaa 180
 tcatgccgct aaccaaggag gttgaggctg cgtact 216

<210> 262
 <211> 308
 <212> DNA
 <213> Zea mays

<400> 262
 cccattcggt ctagccctcc ctccgacact ccgatccatt actcgctatg gacgcggcgg 60
 gcggcgacca gctaagcctg gccgcgggtgc gcgacgcgt ggtgcggctg gaggactccg 120
 tgggtgtcgc gctcatcgag cggccccggc atccgcggaa ccgccagcct acgcgccccg 180
 cgccaccgct ggagaacatt cgctcgtgga gttcttcgtc cggaagcag aggccctcaa 240
 cgcaaaggct ggacattatc aaaagccaga agatgttcca ttcttcctc aagatctacc 300
 ctcacctc 308

<210> 263
 <211> 178
 <212> DNA

<213> Zea mays

<400> 263

ctcaatacaa atgtgagttc ttgtaggctg gacattatca aaagccagaa gatgttccat 60
tcttcctca agatctaccc tcacctctct ttctacaaa gccttccgca aaggtcttgc 120
acccttttgc ttcattgggc accgtgaatg atgcaatatg gaaaatgtat tttgatga 178

<210> 264

<211> 232

<212> DNA

<213> Zea mays

<400> 264

cttttattag ggaagagagg gttgatcgaa gtgaaatatt gacattggat agcattagac 60
aagttttgat tagactagaa gacagcatca tatttggcct tttggagaga gcacagtttt 120
gttacagtgc tgatacatat gatagcaatg ctttccacat ggatggtttt ggcggctttt 180
tggttgaata tatggttaga gaaactgaaa agctccatgc acaggttggg ag 232

<210> 265

<211> 304

<212> DNA

<213> Zea mays

<400> 265

agctggccac caaggccgcg gggcgctgc ccgctgctgc tcaccgcggg ggtctcgccc 60
gggggccgga gggtacgac cgcgttgccct tcggaccagc gcctagaaac aaggggctcc 120
gcgcggccaa caactccgcg acgcccgtgg ctacggaaga gagggttgat cgaagtgaaa 180
tattgacatt ggatagcatt agacaagttt tgattagact agaagacagc atcatatttg 240
gccttttggg gagagcacag ttttgttaca atgctgatac atatgatagc aatgctttcc 300
acat 304

<210> 266

<211> 260

<212> DNA

<213> Zea mays

<400> 266

tggccttcaa gctggccacc aaggccgcgg cggcgtcgcc cgctgctgct caccgcgggg 60
 gtctcgcccc ggggccggag ggtacgagcc gcgttgccct cggaccagcg cctagaaaca 120
 agggggtccg cgcgccaac aactccgcga cgcccggtggc taaggaagag agggttgatc 180
 gaagtgaat attgacattg gatagcatta gacaagtttt gattagacta gaagacagca 240
 tcatatttg ccttttgag 260

<210> 267
 <211> 281
 <212> DNA
 <213> Zea mays

<400> 267

gtcgactaat aaaagaaaag gacaccgatt ctctgatgga tatgctgaca ttcaaggctg 60
 tggaagagaa ggtcaagaag agagtagaga agaaggccag gacgttcggg cagaacgtca 120
 ccttgaggga caatgccact gctggtgaca gcgagtgcaa ggtcgatccc aaagtgtctt 180
 ccaagctgta tgatcagtgg gtgatgccac tgaccaagga tgtcgaagtc gagtatctcc 240
 tgcgccgcct cgattgatca cccgattagt tgtagctgcg a 281

<210> 268
 <211> 227
 <212> DNA
 <213> Zea mays

<400> 268

caagaagaga gtagagaaga aggccaggac gttcggggcag aacgtcacct tggaggacaa 60
 tgccactgct ggtgacagcg agtgcaaggt cgatcccaaa gtgctctcca agctgtatga 120
 tcagtgggtg atgccactga ccaaggatgt cgaagtcgag tatctcctgc gccgcctcga 180
 ttgatcaccg gattagttgt agctgcgaac tttatgtacg cgtgggtt 227

<210> 269
 <211> 451
 <212> DNA
 <213> Zea mays

<223> unsure at all n locations
 <400> 269

aggggnnnna aatttagctg atatcattgc atgtctgtcc ggttccaatt cgacccacgc 60

gtacgaagag cccagatgag caccctttct ttcctgagga tctgcctgag ccccggttgc 120
cagctatgca gtaccaaggg gttttgcac ccattgccga ttctatcaat atcaacaaag 180
agatttgga aatgtatttt gatgaacttc ttccaagatt ggtgaaaaaa ggaagtgatg 240
gtaatgctgg atccagtgt ctttgtgaca cgacctgctt gcaggcgctc tccaaaagga 300
tccactatgg gaagtttgtg gcagaagcta agtttcagga gtccccggaa gcttacatgc 360
catccataat agctcaagac cgtgatcaac tcatgcacct tctcacatat gaaacggtgg 420
aacgtgctat cgaacacagg gtggaaacca a 451

<210> 270
<211> 453
<212> DNA
<213> Zea mays

<400> 270

atgctttcca catggatggg tttggcggct ctttggttga atatatggtt agagaaactg 60
aaaagctcca tgcacagggt gggagataca agagcccaga tgagcacctt ttctttcctg 120
aggatctgcc tgagccccgg ttgccaccta tgcagtacct aagggttttg catcccattg 180
ccgattctat caatatcaac aaagagattt ggaaaatgta ttttgatgaa cttcttccaa 240
gattggtaaa aaaaggaagt gatggtaatg ctggatccag tgctctttgt gacacgacct 300
gcttgcaagc gctctccaaa aggatccact atgggaagtt tgtggcagag gctaagtttc 360
aggagtcccc ggaagcttac atgccagcca taatagctca agaccgtgat caactcatgc 420
accttctcac atatgaaacg gtggagcgtg cta 453

<210> 271
<211> 403
<212> DNA
<213> Zea mays

<400> 271

aagagcccag atgagcacc tttcttttcc aaggatctgc ctgagccccg gttgccaggt 60
atgcggtacc caaaggtttt gcatccatt gctgattcta tcaatatcaa caaagagatt 120
tgaaaaatgt attttgatga acttctacca agattggtga aagaaggaag tgatggtaat 180
gctggatcca gtgctctttg tgacacaacc tgcttgcagg cactctccag aaggatccac 240

tatgggaagt atgtggcaga cgcctagttt caagagtccc ctgaagctta cacgccagcc 300
 ataatagccc aagtctgctt ttgttccaac tattagtatt tctagtacta ctattttcat 360
 ttatttttta atctaattcc aaagtttcag aaccaaattg ttt 403

<210> 272
 <211> 426
 <212> DNA
 <213> Zea mays

<400> 272

cggacgcgtg ggcggacgcg tgggcacata tgaaacgggtg gagcgtgcta tcgaacacag 60
 ggtggaggcc aaagccaaga tcttcgggca agagggtgaac attggtgcta aggacaacgg 120
 cagcccaccg gtctacaaaa tcaggccgag cttgggtcgcc gagctgtaca gctacagaat 180
 catgccgcta accaaggagg ttgaggtcgc gtacttgctt aagaggctgg attgagtgtg 240
 tttacgtagc tgtaaaaactg ccagatccga actcctggta ttaaaccata acatcggtaa 300
 gtaccatttt ctgtgaagag gatgatccga actcctgtca ttaaaccaga acatcagtaa 360
 gtaccagtt ttggggaaag gatggaaaat ataccatgtg tggcaagcaa catgcataat 420
 atcatc 426

<210> 273
 <211> 363
 <212> DNA
 <213> Zea mays

<400> 273

cgcagttcac gcttggtga cgaccgaccc ccattcgttc tagccctccc tccgacactc 60
 cgatccatta ctgcgtatgg acgcgggcggg cggcgaccag ctaagcctgg ccgcggtgcg 120
 cgacgcgctg gtgcggctgg aggactcogt ggtgttcgcg ctcatcgagc gcgcccgga 180
 tccgcggaac gcgccagcct acgcgccgcg cgcaccgct ggagaacatt cgctcgtgga 240
 gttcttcgtc cgggaagcag aggccctcaa cgcaaaggct ggacattatc aaaagccaga 300
 agatgttcca ttcttccttc aagatctacc ctacctctc ttctctacaa agccttcccc 360
 aaa 363

<210> 274
 <211> 426
 <212> DNA
 <213> Zea mays

<400> 274

cggaacgcgtg ggcggacgcg tgggtggcct tcaagctggc caccaaggcc gcggcggcgt 60
 cgcccgtgc tgctcaccgc ggggggtctcg cccggggggcc ggaggggtacg agccgcgttg 120
 ccttcggacc agcgccctaga aacaaggggc tccgcgcggc caacaactcc gcgacgcccg 180
 tggctaagga agagaggggt gatcgaagtg aaatattgac attggatagc attagacaag 240
 ttttgattag actagaagac agcatcatat tcggcctttt ggagagagca cagttttgtt 300
 acaacgctga tacatatgat agcaatgctt tccacatgga tggtttttggc ggctcttttg 360
 ttgaatatat ggttagagaa actgaaaagc tccatgcaca ggttgggaga tacaagagcc 420
 cagatg 426

<210> 275
 <211> 435
 <212> DNA
 <213> Zea mays

<400> 275

ccttcaagct ggtcaccaag cccgcggcgg cgtcgcccgc tgctgctcac tggggagagc 60
 tcgcccgggg gccgcagggt accagccgcg ttggctcttg acacaagccc acaaacacag 120
 ggcgctccgc acggacaaaa tctccgaaac gcccatggct aaggaagaga gggttgatcg 180
 aagtgaata ttgacatggg atagcatcag acaagttttg attagactag aagacagcat 240
 catatttga cttttggaga gagcacagtt ttgttacaac gctgacacat atgatagcaa 300
 tgctttccac atggatgggt ttggaggggtc tttggttgaa tatatgggta gagaaactga 360
 aaagctccat gcacaggttg ggaggtacaa gagcccagat gagcaccctt tcttttccaa 420
 ggatctgcct gagcc 435

<210> 276
 <211> 379
 <212> DNA
 <213> Zea mays

<400> 276

cctcccactt cgtgcgagcg tcccgaacta agttgctcgt ggtggaggtg gtttgtggcg 60
atggccttca agctggtcac caagcccgcg gcggcgctgc ccgctgctgc tcaactgggga 120
gatctcgccc ggtggccgca ggttacgagc cgcgttgctt tcggaccagc gccaggaac 180
aaggggctcc gcacgggcaa caactccgca acgcccattg ctaaggaaga gaggggtgat 240
cgaagtgaaa tattgacatt ggatagcatc agacaagttt tgattagact agaagacagc 300
atcatatttg gacttttggg gagagcacag ttttgttaca acgctgacac atatgatagc 360
aatgctatcc acatggatg 379

<210> 277
<211> 405
<212> DNA
<213> Zea mays

<400> 277

aaagaattca tattggtaaa tatgttgctg aggtgaagtt caaagacgct cctcaagagt 60
atagtcgact aataaaagaa aaggacagca attctctgat ggatatgctg acattcaagg 120
ctgtggaaga gaaggtcaag aagagagtag agaagaaggc taggacgttc gggcagaacg 180
tcaccttgga tgacaatgcc actgctgggtg acagcgagtg caaggctgat cccaaagtgc 240
tctccaagct gtatgatcag tgggtgatgc cactgaccaa ggatgtcgaa gtcgagtatc 300
tctgcgccg cctcgactga tcagtgatca cccgattagc tgtagctgct aactttatgt 360
acgcgtgggt atcagattgc tttgcacatg ctctttatgg cttta 405

<210> 278
<211> 322
<212> DNA
<213> Glycine max

<400> 278

agctgaggca aaatatcaag ctagtccaga ttcatataaa gatgccatta tagcacagga 60
caaggacaag ttgatggaat tgctaacata tcctgaagtt gaagaggcaa ttaagaggag 120
agttgacatg aagaccaaga cttatgggca agaactgggt gtaactacga aggaacatcg 180
aactgaacct gtctacaaaa taaatccaag cttgggttgct gatctatata gtgattggat 240
catgccattg acaaaggaag ttcaagttgc ctatctgttg agaaggttgg attgaacata 300

acaaaaagta ccttttcaat ta

322

<210> 279
<211> 262
<212> DNA
<213> Glycine max

<400> 279

cccacaaata gtcaaacaag gggatgatgg taactctgga tccagtgctg tttgtgatgt 60
aatatgcttg caggctctct caaagagaat tcattatgga aaatatgtag ctgaggcaaa 120
ataccaagct agtccagatt catataaaga tgccattata gcacaggaca aggacaagtt 180
gatggaattg ctaacatatc ctgaagttga agaggcaatt aagaggagag ttgacatgaa 240
gaccaagact tatgggcaag aa 262

<210> 280
<211> 263
<212> DNA
<213> Glycine max

<400> 280

aagacgacag aaggggaaaa agtatggagt ttatacttca gagttcttat tccacaaata 60
gtccaagcaa ggagatgatg gtaactctgg atccagtgtt gtttgtgatg taatatgctt 120
gcaggctctc tcaaagagaa ttcatatgga caaatatgta gctgaggcaa attatcaagc 180
tagtccagat tcatataaag atgccattat agcacaggac aaggacattg ttatggaatt 240
gctaacatat cgtgaagttg aag 263

<210> 281
<211> 299
<212> DNA
<213> Glycine max

<400> 281

tgttggttct ctttcaatgg agtctaagct tttaagagcc accaccatct cagtcccttc 60
aacaccctca tgcgctttcc atcgcacaaac tcgcaaggct tcgatttcct tcaacccac 120
ctcggttttc gccccaaaaa gcaatctttc tctccaggca catgcggctt ccacgcagtc 180
agtgccaaca aagaaaagaa ttgatgagag tgacaacctg acccttgatc atataagacg 240

ttcttttagtt cgtcaagagg atagcataat cttcagtctc atcggcgagc acaatactg 299

<210> 282
<211> 388
<212> DNA
<213> Glycine max

<400> 282

gccatttttag cccaggacaa ggatagggttg atggatatgc taacatatcc gaaagttgaa 60
gaggaaaaaca tgataagagt agaggaaaag gccaaaaaat ttggcctagt agtggattta 120
aatgcaaaga agcctcgagc tgagccactg tacataataa atccaagtgt ggtttctgat 180
ctgtatggcc attgggtcat gccattgaca aaggaagtgc aagttgcata tttattgagg 240
aggctggact aaacatatag taagagttct tggttatggt ggtggtagag aaccaataat 300
tcatgtatat aaataaagct tagactgagt aataatgtct ttgaatggac ttgaatttga 360
tagaaattaa caaacaccgt tttctttc 388

<210> 283
<211> 319
<212> DNA
<213> Glycine max

<400> 283

acgcgtcagt acggctgcga gaagacgaca gaagggggta gaatttggtg ttaagaatac 60
agaggccatt caagctaagg ctggaagata caaaaaccct gaagaaaacg ctttcttccc 120
agaaaattta ccaccatcaa ttgtgccatc ttactccttc aaacagtttt tgcacctcgg 180
agctgcttca attaacatta acaagtccat ctggaaaatg tatttccaag agttacttcc 240
attggttgct acttcggggg atgatggaaa ctatgcacaa actgcagcta atgatctttc 300
attagtgcag gccatctct 319

<210> 284
<211> 424
<212> DNA
<213> Glycine max

<400> 284

cccacgcgtc cgtacggctg cgagaagacg acagaagggg ggcaagaact ggttgtaact 60

acgaaggaac atcgaactga acctgtctac aaaataaatac caagcttggt tgctgatcta 120
 tacagtgatt ggatcatgcc attgacaaag gaagttcaag ttgcctatct gttgagaagg 180
 ttggattgaa cataacaaaa agtacctttt caattacagt gtttataggg ttatttatct 240
 tttctaggaa atgatacttg caatgggtaa tttctcttga atcatgattc atgactataa 300
 acttgagctt ttgtaactaa catatgagga agctgatatt gggttcttat ataataatta 360
 atggcatctt ttatgttggt ccaaaaaaaaa gacatggact aatccaaaaa aaagcggccg 420
 ctct 424

<210> 285
 <211> 297
 <212> DNA
 <213> Zea mays

<400> 285
 tgccctcaca agccagaagg ttccatgttt gtcattggtga aactaaattt gtatcttttg 60
 gagagcatcc atgatgatat tgatttttgt tgcaagctgg caaaagaaga gtccgtgatt 120
 ttgtgtccag ggagtgtttt gggaaatggaa aactggatcc gtatcacttt cgccattgat 180
 tcatctttctc ttcttgatgg tcttgagagg ctgaaatctt tctgccaaag gcataagaag 240
 aagaatttgc ttaatggcca ttaactatat acgaacttcag agttgttacc cacttcc 297

<210> 286
 <211> 291
 <212> DNA
 <213> Zea mays

<400> 286
 cacatgccct cacaagccag aaggttccat gtttgtcatg gtgaaactaa atttgtatct 60
 tttggagagc atccatgatg atattgattt ttgttgcaag ctggcaaaag aagagtccgt 120
 gatttttgtg ccaggaggatg ttttgggaat ggaaaactgg atccgtatca ctttcgccat 180
 tgattcatct tctcttcttg atggtcttga gaggtgaaa tctttctgcc aaaggcataa 240
 gaagaagaat ttgcttaatg gccattaact atattcgact tcaaagttgt t 291

<210> 287
 <211> 265

<212> DNA
 <213> Zea mays
 <400> 287
 ctcttgccga caagaatact gttgccatgg tcattgtgaa cccaggaaac ccatgtggca 60
 atgtgtactc ctatgagcac ctggccaagg tcgctgagac cgcgcgaaag cttggcatat 120
 tcgtcatagc agatgagggt tacgcacact tgacatttgg agagaggaaa tttgtgccga 180
 tgggtgtgtt tggggctgtg gctccagtgt taacactggg gtccatatca aagagatgga 240
 tgggtgcctgg atggcggcctt ggatg 265

<210> 288
 <211> 296
 <212> DNA
 <213> Zea mays
 <400> 288
 aaaccccaac aatccttgcg gcagtgtcta caccogtgaa catttagcca aggttgcaga 60
 ggtagcaagg aagcttggaa tactaatcat cgctgatgaa gtgtatggaa acctgggtgtt 120
 tggggacacc ccttacgtcc caatgggtgt ctttgccac attgccctg tgttgagcat 180
 aggatcacta tcgacgagat ggatagtgcc tgggtggcga cttgggttggg tagctgtatg 240
 tgatcccaac aagattctgc aagacaccaa gatcattgca tcaataacaa acttcc 296

<210> 289
 <211> 232
 <212> DNA
 <213> Zea mays
 <400> 289
 cggctcgagc cttgcggcag tgtctacacc cgtgaacatt tagccaaggt cgcggaggta 60
 gcaaggcagc ttggaatact agtcatcgct gatgaagtgt atggaaacct ggtgtttggg 120
 gacaccctt acgtcccaat ggggtgtctt ggccatattg cccctgtgtt gagcttagga 180
 tcactatcga agagatggat agtgcctggg tggcgacttg gttgggtagc tg 232

<210> 290
 <211> 253
 <212> DNA
 <213> Zea mays

<400> 290

cgacgacatc ttctgtcaccg ccggaggacg acaagccatc gaggtggtgg tctcagtcct 60

cgcgagccg ggcaccaaca tactgtctcc gaggccgggc tatccgaact acgaggcgcg 120

cgcagggctg cacaacctgg aagtccgcg gttcaatctg atccccgaga gaggggtggga 180

gattgacatc gacggtctgg agtcgatcgc cgacaagaac accaccgcca tggatcatcat 240

aaacccaac aac 253

<210> 291

<211> 235

<212> DNA

<213> Zea mays

<400> 291

cccacgcgtc cgtctgtggc gacacctgtc gagcgacctt ccatacaagc tgtcgagcga 60

cgacatcttc gtcaccgccc gaggcgcaa gccatcgagg tgggtggtctc agtcctcgcg 120

caccggggcac caacatactg ctcccagggc cgggctatcc gaactacgag gcgcgcgcag 180

ggctgcacaa cctggaagtt cgccggttca atctgatccc cgagagagggg tggga 235

<210> 292

<211> 398

<212> DNA

<213> Zea mays

<223> unsure at all n locations

<400> 292

cccacgcgtc cgggtggtgt ctcagtcctc gcgcagccgg gcaccaacat actgtctccg 60

aggccggggt atccgaacta cgaggcgcg gcagggctgc acaacctgga agttcgccgg 120

ttcaatctga tccccgagag aggggtgggag attgacatcg acggtctgga gtcgatcgcc 180

gacaagaaca ccaccgccat ggtcatcata aacccaaca acccttgccg gagtgtctac 240

accctgagc atttgccaa ggtcgccgag gtggcaagga agcttggaat actggtcatc 300

gctgatgagg tgtatggaaa tctggtgttt ggggacaccc ctttcgtccc catgggggtgt 360

cttgccaca ttgccctgg gttgaccata ngatcact 398

<210> 293

<211> 246
 <212> DNA
 <213> Glycine max

 <400> 293

 cgttttttctc accattggtg gcacacaagc catagatata attttacctt ccctagcacg 60
 tcctggtgcc aacattctcc ttccaaaacc agggtagcca cattatgaac ttcgtgccac 120
 tcgttgctctt cttgaaattc gacactttga tcttttgctt gagagaggat gggaagttga 180
 ccttgactct ttggaagctt tggcagatga gaacactgtg gccattgttt tcatcagttc 240
 tagtag 246

<210> 294
 <211> 262
 <212> DNA
 <213> Glycine max

 <400> 294

 cgaacccttc agtcacacaa gtttcgtggc tatgctccca ctgcaggctt tccacaggcc 60
 aggattgcc a ttgctgaata cctgtctcgt gaccttcctt accaattatc aaatgaggat 120
 gtttatatca cttgtggatg cacacaagcc attgatgatt cagtggcaat gcttgctcgc 180
 .cccggtgcaa acatcttgc tccaagacca ggcttccac tctatgaact tagtgcttca 240
 tttagagggg ttgaagtgag gc 262

<210> 295
 <211> 264
 <212> DNA
 <213> Glycine max

 <400> 295

 tgcttccaga gaaagggttg gaggttgatc tagatgctgt tgaagctctt gctgatcaga 60
 acacagtggc gttggcgatc ataaaccctg ggaatccttg tgggaatgtg tacagttacc 120
 accatttgga gaagattgct gaaactgcaa aacgggttg aacaattgtg atctctgatg 180
 aagtttatgg tcaccttgca ttggggagca agccttttgc accgatggga gtttttggct 240
 ctactgttcc tgttctcact cttg 264

<210> 296

<211> 244
 <212> DNA
 <213> Glycine max

 <400> 296

 tgttcctggt ctgactcttg gctcattttc taagagatgg atagttcctg gatggaggct 60
 tggttgggtt gttacaaatg atccatctgg cactttttaga aatccaaagg tagatgagcg 120
 aattaaag tactttgato ttttgggagg tcttgccacc ttcattccagg cagctctacc 180
 tcagataatt gcgcatactg aagagggttt cttcaagaaa accattgata atttgaggca 240
 tgct 244

<210> 297
 <211> 247
 <212> DNA
 <213> Glycine max

 <400> 297

 cttgcatttg caggcagcct tttgtgcaa tgggagtttt tggctatatt gttcctgttc 60
 tgaatctagg ctcatcttct aagagatgga tatttcctgg atggaggctt ggttgggttg 120
 tgacaaatga tccatctggc acttgtagaa atccaaagg atatgagcg tttaaaaagt 180
 actttgatct tttgggagg gcagccacct tcatccaggc agctgtacct cagataattc 240
 gcatact 247

<210> 298
 <211> 246
 <212> DNA
 <213> Glycine max

 <223> unsure at all n locations
 <400> 298

 ttgaagaggc tgtcgctgat gctottcaat ctgcgaagtt tcatggctat gctcccactg 60
 ctggacttct ccaggctaga attgcaattg ctgaatatta tctcgtgacc ttccttatca 120
 attatcacga gatgatgtct tcatcacttg tggatgcaca caagccattg atgtttcggg 180
 ggcgatgctt gctcgccctg gtgcaaacat cnttccaagg ccaggcttcc caatctatga 240
 actttg 246

<210> 299
 <211> 396
 <212> DNA
 <213> Glycine max

<400> 299

atagagagta agcctgagat catggaaaaa gttggtgtgg ctgtaaatag caaaaatcaa 60
 gaatccaaag caacttccac cattaccatt aagggtttca tgagccttct aatgaaaagt 120
 gtagatgaga atggtgatgg tagcaagaga gttattttctc tgggtatggg tgaccaact 180
 ctcaccactt attttcccat ctcaaatgta gctgaaaaag ctgttgctga agcacttcag 240
 tcacacaggt ttcggtggcta tgctccact gcaggcttc cacaggccag gattgcaatt 300
 gctgaatacc tgtctcgta ccttccttac caattatcaa gtgatgatgt ttacatcacc 360
 tgtggatgca cacaagccat tgatgtttca gtggcg 396

<210> 300
 <211> 443
 <212> DNA
 <213> Glycine max

<400> 300

tggggttgtg gctgtgaaca acaacatcaa caactatgaa tccaaggcaa cttccaccgt 60
 caccattaag ggcattotca gccttotaat ggaaagcatt gatgatgaga attgtgatgg 120
 tgggtggaagc aagaagagag ttattttctct tgggtatgggt gaccaactc tcaccacatt 180
 gttccacaca ccaaagggtt ttgaagaggc tgctcgctgat gctcttcaat ctcgcaagtt 240
 tcatggctat gctccactg ctggacttct ccaggctaga attgcaattg ctgaatatct 300
 atctcgtagc ctttcttata aattatcacg agatgatgtc ttcatcactt gtggatgcac 360
 acaagccatt gatgtttcgg tggccatgct tgctcgccct ggtgcaaaca tcttgcttcc 420
 aaggccaagc tttccaatct atg 443

<210> 301
 <211> 278
 <212> DNA
 <213> Zea mays

<400> 301

tgtcacgtat catttaaaac taatatataa cttttaaatt gaatatttat ttgtaatcat 60

ttttaacgat tatTTacaag tttttttotaa tatggcatct tggtttatag aagttcttcc 120
 aacagctccg atcgaaattt ttgctcttgc tcgagctttt cgggaagatt cttttgcaga 180
 aaaagttgac cttggcattg gagcctatcg tactgatgaa ggtcaaccat gggTacttcc 240
 agttgttcgt gaagccgaaa tcagcattgc caatgata 278

<210> 302
 <211> 304
 <212> DNA
 <213> Zea mays

<400> 302

ctctggagct gaggaaggct atctgcaaaa agcttgagga ggagaatggt ctatcact 60
 ccgccgatca ggtgctagta agcaatggag ccaagcagtg cattacacaa gcagtactcg 120
 ctgtctgctc acctggcgat gaagtTttga tacctgcacc atattgggtc agtaccctg 180
 agatggctag actggctggt gcaacgccag ttattctccc tacaagcata tcagacaatt 240
 acctgctaag gccagagtca cttgcctcag tgatcaatga aaattcaagg atcttgattc 300
 tctg 304

<210> 303
 <211> 128
 <212> DNA
 <213> Zea mays

<400> 303

agaatttctt gcaaggcact atcacgaggt taaacttttc ttgctcctat ctgttttgct 60
 gcttcctgat tataatgcat gactgctaaa tcatacaaat atattccagc gcactatcta 120
 catccac 128

<210> 304
 <211> 322
 <212> DNA
 <213> Zea mays

<223> unsure at all n locations
 <400> 304

tngggagatc acccanaagt cttcacccta tctggcttga acgttaggag ctaccgctat 60

tatgatcctg caacatgcag ccttcacttc gaaggactcc tggaagacct cggttctgct 120
ccttcagggt caattgtact gctgcatgcc tgtgtcacacc accctactgg agtagatcct 180
accatcgaac agtgggaaca gattaggcag ctgatgagat canaatcact gcttccgttc 240
tttgacagtg cctatcaagg ctttgcaagt cggagtcttg acnaagatgc tcagtcagtg 300
cgtatgtttt gtgctgatgg tg 322

<210> 305
<211> 302
<212> DNA
<213> Zea mays
<400> 305

tgcgaggccg agcgccggat cgcgggcaac ctcaacatgg agtaccttcc gatgggaggg 60
agcatcaaga tgattgaaga gtcaactgaag ctggcgtagc gagaagattc tgacttcac 120
aaagataaga ggatagcagc ggtgcaggcg ctttcaggca ctggtgcctg ccggctcttt 180
gctgatttcc aaaagcgttt tttgccggat tcgcagatct acataccaac accaacgtgg 240
tccaaccatc acaatatttg gagggatgct caagtgccac agaagacatt cacatactac 300
ca 302

<210> 306
<211> 138
<212> DNA
<213> Zea mays
<400> 306

gttcattctt tttgcttcat gcatgtgtc ataatcccac cgggtgtagct cctacggagg 60
aaccatggcg cgaaatatcc catcagttca aggtgaacaa acatttacca ttctttgaca 120
tggaatcacc cgggtttg 138

<210> 307
<211> 181
<212> DNA
<213> Zea mays
<400> 307

gttcattctt tttgcttcat gcatgtgtc ataatcccac cgggtgtagat cctacggagg 60

aacaatggag agaaatatcc catcagttca aggtgaaaaa acattttcca ttctttgaca 120
 tggcatacca agggtttgcc agtgggtgatc cagagagagc tgccaaggcc atctgatttt 180
 c 181

<210> 308
 <211> 184
 <212> DNA
 <213> Zea mays

<400> 308

gttcattctt tttgcttcat gcatgtgctc ataataccca ctgtgaagat cctaataaga 60
 cccactggag agaacatata cccatacagt tcaagggtgaa aaaacatttt ccattacttt 120
 gacatggcat accaagggtt tgccagtggg gatccagaga gagatgccaa ggcaatccga 180
 attt 184

<210> 309
 <211> 135
 <212> DNA
 <213> Zea mays

<400> 309

aattcattct ttttgttca tgcattgtgc cataatccca gcggtgtaga tcctatggac 60
 ggactatgga gagaaatgac ccatcagttc aagggtgaaaa aacattttcc attctttgac 120
 atggcattca aggggt 135

<210> 310
 <211> 310
 <212> DNA
 <213> Zea mays

<400> 310

cagacatatt tgtctctgat ggtgccaaat gtgacatata tcgcttgacg gtcctttttg 60
 gatctaattgt gacaattgag gtccaagatc catcataccc tgcatatggt gattcaagtg 120
 ttatcatggg gcaaactgac ttatatcagc aagacgttca gaagtatgga aacattgagt 180
 acatgagatg cgggccagaa aatggatttt tctgatctg tcaactgtcc ctaggacaga 240
 tattattttc ttttgttcac ccaacaatcc tactgggtgct gctgcatctc gggaccaact 300

aaccaaatta 310

<210> 311
 <211> 296
 <212> DNA
 <213> Zea mays

<400> 311

gctgcggcag gccggcgtgc cggttatcgg tctagccgcg ggggagccag acttcgacac 60
 gccgcccgcg atcgcgagg cgggatggc tgcaattagg aatggttata caagatacac 120
 tcctaagtct gggacttttg agctgaggaa ggctatactg tactaaactc caggagggaa 180
 cggggtatcc tacctcccag atgaggtgct ggtgagcaat ggagctaagc aatgcatcac 240
 ataagctgtg cttgcagttt gctcacctgg tgatgaggtt ttgattccag ccccat 296

<210> 312
 <211> 119
 <212> DNA
 <213> Zea mays

<223> unsure at all n locations
 <400> 312

gaccacnagt ggtccacoga ttggactctg gaentgaagg ccatggctgt taggatcatt 60
 aacatgaggc aacaactatt tatgcgctga atccagagga anccctggtg attgagcct 119

<210> 313
 <211> 246
 <212> DNA
 <213> Zea mays

<400> 313

ggctaagatc aagtgtagta tctggtctta tcaatttaat atctgatatg tggactatgt 60
 gttcactttg atattaaatt tattttctgt ggcggagagt ccaccaccgt ggcttgccac 120
 tggccccctt gagcgctcgt cggactgggc cccttgagcg tcgctcggcc gttgcactac 180
 tggctgagcc tggcgacccc caaccaatcc aattcgagat tttttcccca accaatctaa 240
 tttgag 246

<210> 314
 <211> 295

<212> DNA
 <213> Zea mays
 <400> 314
 cacttaagga aaatcttgaa aagctaggtt cacctttgtc atgggatcat atcactaatc 60
 agattggaat gttctgctac agtgggatga cacctgaaca agttgaccgt ttaacaaatg 120
 aataccacat ttacatgacc cgcaatggga ggataagcat ggctggtggt acgacaggaa 180
 atgttagtta cctagcaaat gcaattcatg aggttaccaa accaaattga gttagggtcc 240
 taccttcttt ggtcgatgga agctgatgga atgagactgt gaagcggcgt ttccc 295

<210> 315
 <211> 262
 <212> DNA
 <213> Zea mays
 <400> 315
 atcagattgg aatgttctgc tacagtggga tgacacctga acaagttgac cgtttaacaa 60
 atgaatacca catttacatg acccgcaatg ggaggataag catggctggt gtaacgacag 120
 gaaatgttgg ttacctagca aatgcaattc atgaggttac caaaccaa at tgagttaggg 180
 tgctaccttc tttggtcgat ggaagctgat ggaatgagac tgtgaagcgg cgtttccccc 240
 ctctgttcct gacagaaata ag 262

<210> 316
 <211> 133
 <212> DNA
 <213> Zea mays
 <400> 316
 atcagattgg aatgttctgc tacagtggga tgacacctga acaagttgac cgtttaacaa 60
 atgaatacca catttacatg acccgcaatg ggaggataag catggctggt gtaacgacag 120
 gaaatgttgg tta 133

<210> 317
 <211> 372
 <212> DNA
 <213> Zea mays
 <400> 317

aacgagcaag ggccgcagcc ggagctccaa tggcctcctt ctctccctc tctgcctcct 60
 cctccacctc caccctgtcc ttcaacctcc ccgcaaaaac ctccgctggc acaggctccc 120
 tgtcattcca cagggcgagg gagtcgcaga agtccagggc caggatggtg acggtgcggg 180
 cggaggcggt tgacacgacc atcagcccgc gggatgaatgc gctcaggccg tccaagacca 240
 tggccatcac cgaccaggcc acggcgctgc gacaggccgg cgtgccagtc atcggactcg 300
 ccgctgggga gcccgaattc gacacgccag ccgtgatcgc cgaggctggg ataaatgcc 360
 tcagagatgg gg 372

<210> 318
 <211> 305
 <212> DNA
 <213> Zea mays

<400> 318
 cggaccgtgg tcccgtttcg ctctctgcgc ccgccaccgc acaagaagct agctcctgcc 60
 tgtaccgccc cgtcatggcg atgtatatca gtgcagctcc tccgcggccc ggcgcccgt 120
 gctgccgcgc cctaggett c tggcggtgag ggcgatggcg tgcctgctct tcggccacgt 180
 cgagccggcg cccaaggacc ccctctctcg cgtcaccgag gctttctctc ccgacccctc 240
 gtccgacaaa gtgaacgtcg gcgtcggcgc ctaccgggac gacaacggcc agcccgtcgt 300
 gctca 305

<210> 319
 <211> 294
 <212> DNA
 <213> Zea mays

<400> 319
 cggagccgtg ggacaaaagc ccacagcttc ttctccctac tctccagtc ctccgtcatc 60
 cgtttcgtct tctgccgcgc ccaccgcaca agaagctagc tctgcctgt accgccccgt 120
 catggcgatg ctatccgcgc cacctcctcc gcggcccggc gcccgctgct gccgccgct 180
 aggtttctgg cggtaggggc gatggcgctg tgcctcttcg gccacgtcga gccggcgccc 240
 aaggacccca tctcggcggt caccgaggct ttctcgcgc acccctcgtc cgac 294

<210> 320
 <211> 263
 <212> DNA
 <213> Zea mays

<400> 320

caagaagcta gctcctgcct gtaccgcccc gtcattggcga tgctatcccc cgcgcgctcc 60
 tccgctgccc ggcgcccgtt gctgcgcgcg cctaggettcc tggcggtgag ggcgatggcg 120
 tcgtcgtctt tcggccacgt cgagcggcgc gccaaaggacc ccattcctcg cgtcaccgag 180
 gctttcctcg ccgacgcctc gtccgacaaa gtgaacgtcg gcgtcggcgc ctaccgggac 240
 gacaacggcc agcccgtcgt gct 263

<210> 321
 <211> 290
 <212> DNA
 <213> Zea mays

<400> 321

gtgacaaaag cccacagctt cttctcccta ctctccagc cctccgtcat ccgtttcgtt 60
 ctctgccgcc gccaccgcac aagaagctag ctctgcctg taccgccccg tcatggcgat 120
 gctatccccg gcagctcctc cgcggccccg cgcgcgctgc tgcgcgcgc taggcttctg 180
 gcggtgaggg cgatggcgtc gtcgtctctc ggccacgtcg agccggcgcc caaggacccc 240
 atcctcggcg tcaccgaggc tttcctcgcc gacccctcgt ccgacaaagt 290

<210> 322
 <211> 319
 <212> DNA
 <213> Zea mays

<400> 322

gaaaattgca gatgtcattc aagagaaaaa gcatatgcca ttctttgatg ttgcatatca 60
 aggttttgcc agtagaagcc ttgatgaaga tgcattttct gtcaggcttt ttgttaagcg 120
 tggcatggaa gtatttggtg cacaatttta cagcaagaac cttggtctat attctgaaag 180
 gattggtgcg ataaatgtcg tgtgctcagc accagaagtt gcagataggg taaagagcca 240
 gctgaaacga ttggcacgtc ccattgtact gaacccccct attcacggtg ccaagatagt 300
 tgccaacggt gttggtgat 319

<210> 323
 <211> 295
 <212> DNA
 <213> Zea mays

<400> 323

ggttggtgca ataaatgtcg tgtgtcagc accagaagtt gcagataggg taaagagcca 60
 gctgaaacga ttggcacgtc ccatgtactc gaacccccct attcacggtg ccaagatagt 120
 tgccaacggtt gttggtgatc caaccatggt tggatgaatgg aaacaagaga tggagctaata 180
 ggctggacgg atcaagaatg taagacagaa gctctacgac agtttgtctg ccaaggacaa 240
 gagcggcaag gactggtctt tcattctgag gcagattggc atgttctcct acacc 295

<210> 324
 <211> 291
 <212> DNA
 <213> Zea mays

<400> 324

aatcttacag caagaacctt ggtctatatt ctgaaagggg tggatgcgata aatgtcgtgt 60
 gctcagcacc agaagttgca gatagggtaa agagccagct gaaacgattg gcacgtccca 120
 tgtactcgaa cccccctatt cacggtgcc aagatagttgc caacgttggt ggtgatccaa 180
 tcatgtttgg tgaatggaaa caagagatgg agctaattggc tggacggatc aagaatgtaa 240
 gacagaagct ctacgacagt ttgtctgcc aggataagag cggcaaggac t 291

<210> 325
 <211> 278
 <212> DNA
 <213> Zea mays

<400> 325

cccacgcgtc cgcaactcct gaacagtggg agaaaattgc agatgtcatt caagagaaaa 60
 agcatatgcc attctttgat gttgcatatc agggttttgc cagtgggaagc cttgatgaag 120
 atgcattttc tgtcaggctt tttgttaagc gtggcatgga agtggtttgtt gcacaatctt 180
 acagcaagaa ctttggttta tattctgaaa gggttggtgc aataaatgtc gtgtgctcag 240
 caccagaagt tgcagatagg gtaaatagcc agctgaaa 278

<210> 326
 <211> 318
 <212> DNA
 <213> Zea mays

<400> 326

cccacgcgtc cgctaattggc tggacggatc aagaatgtaa gacagaagct ctacgacagt 60
 ttgtctgcc aaggataagag cggcaaggac tgggtctttca ttctgaggca gattggcatg 120
 ttctctctaca ccggcttgaa caaagcacag agtgacaaca tgacggataa atggcatatt 180
 tacatgacca aggatgggcg gatctcctta gctgggctgt ccctggctaa gtgtgattat 240
 cttgccgacg ccatcatcga ttcttccat aatgtgaact aggctgaggt acgatagttg 300
 aggggtcaagc tattgatg 318

<210> 327
 <211> 271
 <212> DNA
 <213> Zea mays

<400> 327

ctttttgtta agcgtggcat ggaagtgttt gttgcacaat cttacagcaa gaaccttggg 60
 ctatattctg aaagggttgg tgcgataaat gtcgtgtgct cagcaccaga agttgcagat 120
 agggtaaaga gccagctgaa acgattggca cgtcccatgt actcgaaccc ccctattcac 180
 ggtgccaaaga tagttgccaa cgttgttggg gatccaatca tgtttgggtga atggaaacaa 240
 gagatggagc taatggctgg acggatcaag a 271

<210> 328
 <211> 251
 <212> DNA
 <213> Zea mays

<400> 328

gccattcttt gatgttgc atcagggttt tgccagtgga agccttgatg aagatgcatt 60
 ttctgtcagg ctttttgtta agcgtggcat ggaagtgttt gttgcacaat cttacagcaa 120
 gaatcttggg ttatattctg aaagggttgg tgcaataaat gtcgtgtgct cagcaccaga 180
 agttgcagat agggtaaata gccagctgaa acgattggca cgtcccatgt actcgaaccc 240

ccctattcac g

251

<210> 329
<211> 263
<212> DNA
<213> Zea mays

<400> 329

gccattcttt gatgttgc atcaggggtt tgccagtga agccttgatg aagatgcatt 60
ttctgtcagg ctttttgta agcgtggcat ggaagtgtt gttgcacaat cttacagcaa 120
gaaccttggt ttatattctg aaaggggtgt tgcaataaat gtcgtgtgct cagcaccaga 180
agttgcagat agggtaaata gccagctgaa acgattggca cgtcccatgt actcgaaccc 240
ccctattcac ggtgccaaga tag 263

<210> 330
<211> 274
<212> DNA
<213> Zea mays

<400> 330

tgaatggaaa caagagatgg agctaattggc tggacggatc aagaatgtaa gacagaagct 60
ctacgacagt ttgtctgcca aggacaagag cggcaaggac tggctctttca ttctgaggca 120
gattggcatg ttctcctaca ccggcttgaa caaagcgcag agtgacaaca tgacggataa 180
atggcatatt tacatgacca aggatgggag gatctcgtaa gctgggctgt ccctggctaa 240
gtgtgattat cttgccgacg coactcatga ttct 274

<210> 331
<211> 252
<212> DNA
<213> Zea mays

<400> 331

taaagagcca gctgaaacga ttggcacgtc ccatgtactc gaacccccct attcacggtg 60
ccaagatagt tgccaacgtt gttggtgatc caatcatgtt tggatgaatg aaacaagaga 120
tgagagcta atggctggacgg atcaaggatg taagacagaa gctctacgac agtttgtctg 180
ccaagataa gagcggcaag gactgggtct tcattctgag gcagattggc atgttctcct 240

acaccggctt ga

252

<210> 332
<211> 240
<212> DNA
<213> Zea mays

<400> 332

gcacaatctt acagcaagaa ccttggttta tattctgaaa gggttggtgc aataaatgtc 60
gtgtgctcag caccagaagt tgcagatagg gtaaatagcc agctgaaacg attggcacgt 120
cccatgtact cgaaccccc cttcacgggt gccaaagatag ttgccaacgt tgttggtgat 180
ccaaccatgt ttggtgaatg gaaacaagag atggagctaa tggctggacg gatcaagaat 240

<210> 333
<211> 268
<212> DNA
<213> Zea mays

<400> 333

caagagcggc aaggactggt ctttcattct gaggcagatt ggcatgttct cctacaccgg 60
cttgaacaaa gcgcagagtg acaacatgac ggataaatgg catatttaca tgaccaagga 120
tgggcggatc tcgttagctg ggctgtccct ggctaagtgt gattatcttg ccgacgccat 180
catcgattcc ttccataatg tgaactaggc tgagatatgg agcaacaacg acggcggaga 240
agctgttttg cgtccacgac acaagctg 268

<210> 334
<211> 251
<212> DNA
<213> Zea mays

<400> 334

tgtttggtga atggaaacaa gagatggagc taatggctgg acggatcaag aatgtaagac 60
agaagctcta cgacagtttg tctgccaagg ataagagcgg caaggactgg tctttcattc 120
tgaggcagat tggcaggtct cctacaacgg cttgaacaaa gcacagagtt accacatgac 180
gggtaaatgg gctaattaac atgaccaaga tgggaggatc tccttagctg ggctgtccct 240
ggctaagtgt g 251

<210> 335
 <211> 249
 <212> DNA
 <213> Zea mays

<400> 335

gtgattatct tgcgcagcc atcatcgatt ccttcataa tgtgaactag gctgaggtac 60
 gatagttgag ggtcaagcta ttgatgttta gticcgtgga cgctaggctg ggatttttgg 120
 gtccttccag ctatacagct cttcogttgt gctccatctg gtgtaacttg gataaataaa 180
 aattttgtcg ctgaactaaa actcgtgtgc ttttttacct gtaactgtaa ggtcagcgcg 240
 tggctacag 249

<210> 336
 <211> 193
 <212> DNA
 <213> Zea mays

<400> 336

gtcgcgtgaac taaaaaatat tttatgatcc aagttacacc agatggagca caacggaaga 60
 gctgtatagc tggaaggacc caaaaatccc agcctagcgt ccacggaact aaacatcaat 120
 agcttgaccc tcaactatcg tacctcagcc tagttcacat tatggaagga atcgatgatg 180
 gcgtcggcaa gat 193

<210> 337
 <211> 314
 <212> DNA
 <213> Zea mays

<400> 337

cggacgcgtg gcgagacgcg tgggctccct tcttcagtgc agcagcaggc cagcgagacc 60
 caccaccctc actcccgct cccatccgct gcttactcgc caccggaga tggccaccgc 120
 cgccgccttc tccgtctcct cgccggcggc ctccgccgtc gccgcgcgat ccaaggtgtt 180
 tggaggagtt aaccaggcga gaactagaac tggctgccgc gtcggcatca cgcggaagaa 240
 ctttgccgt gtcatgatgg cccttgcaat ggatgtttct cgttttgaag gattgccaat 300
 ggctcctcca gacc 314

<210> 338
 <211> 285
 <212> DNA
 <213> Zea mays

<400> 338

aagcgacggg cgtcatatcc catcctgata tctcctccct tcttcagtgc agcagcaggc 60
 cagcagcacg ccacccgccc cactcctgcc tccgatccgc tgcttactcg ccacccggag 120
 atggccacccg ccgcccgcctt ctccgtctcc tcgccggcgg cctccgccgt cgcgcgcga 180
 tccaaggtgt ttggaggagg agttaaccag gcgagaacta gaactggctg ccgcgtcggc 240
 atcacgcgga agaactttgg ccgtgtcatg atggcccttg cagtg 285

<210> 339
 <211> 263
 <212> DNA
 <213> Zea mays

<400> 339

cccacgcgtc cgactagttc tagttctcgc ctggttaact cctccaaaca cttgggatcg 60
 cgcggcgacg gcggaggccg ccggcgagga gacggagaag gcggcggcgg tggccatctc 120
 cgggtggcga gtaagcagcg gatcggaggg ggtagtgagg cgggtggcgt gccgctggcc 180
 tgctgctgca ctgaagaagg gagcgcccc tatatacgga ggggcccgag ctcatcgccg 240
 cgccccctcc ctccctgcgc ctg 263

<210> 340
 <211> 116
 <212> DNA
 <213> Zea mays

<400> 340

ctcccgctc cgatccgctg cttactcgcc acccgagat ggccaccgcc gccgccttct 60
 ccgtctcctc gccggcggcc tccgccgtcg ccgcgcgata caaggtgttt ggagga 116

<210> 341
 <211> 260
 <212> DNA
 <213> Zea mays

<400> 341

atggagcact actgcttaga agatgctcat attgtcaacc tcttctcggt ctcaaaggct 60
tatggaatga tgggggtggcg tgtaggatac attgcatttc caaatgaagc tgatggcttc 120
catgatcagc tcctcaagggt gcaagacaac ataccgatct gcgcctccat catcgggcag 180
cgcttgccgc tctactcgct ggaggccggc cccgagtga tcaaagaacg ggtgaaagac 240
ctgggtgaaaa accgggcgct 260

<210> 342

<211> 274

<212> DNA

<213> Zea mays

<400> 342

ctttatgtat gatggaatgg agcactactg cttagaagat gctcatattg tcaacctctt 60
ctcgttctca aaggcttatg gaatgatggg gtggcgtgta ggatacattg catttcctaaa 120
tgaagctgat ggcttccatg atcagctcct caagggtgcaa gacaacatac cgatctgcgc 180
ctccatcctc gggcagcgct ggcgctctac tcgctggagg ccggccccga gtggatcaaa 240
gaacgggtga aagacctggt gaaaaaccgg gcgc 274

<210> 343

<211> 320

<212> DNA

<213> Zea mays

<400> 343

ctttaggag ctgccagggtg tcaagatata ggaacctcag ggagccttct atttattcat 60
cgacttcagc tcgtactatg ggtctgaggt ggaagggtttt ggtaccatca aggactctga 120
gtccctctgt ctgttcctgt tggagaaggc acagggttgcg cttgtccctg gggatgcatt 180
tggcgatgac aagggtgttc gcatttcata tgctgcagct atgtcgacac tgcaaactgc 240
aatgggaaag ataaaagaag cgatggctct gctcaggcac cctgttgccg ttttaacaaaa 300
ccaacgtatc gctaatacgt 320

<210> 344

<211> 295

<212> DNA
 <213> Zea mays

<223> unsure at all n locations
 <400> 344

gttgatcaat aatccgtcac gtgtcaagga gtacctacca atcaccggtc tggctgaatt 60
 caataagctg agcgctaagc ttattcttgg cgctgacagc cctgctattc aggagaatag 120
 ggttgctacc gtgcagtgcc tatcgggtac tggttcttta gaagtcggag gtgaatttct 180
 tgcaaggcac tatcacgagc gcactatcta catcccacaa ccaacctggg ganatcaccc 240
 aaagtcttca cctatctggc ttgaacgtag gagctacgct atatgatctg cacat 295

<210> 345
 <211> 299
 <212> DNA
 <213> Zea mays

<400> 345

gttgatcaat aatccgtcac gtgtcaatga gtattctacca atcaccggtc tggctgaatt 60
 caataagctg agcgctaagc ttattctttag cgctgacagc cctactattc aggagaatag 120
 ggttgctacc gtgcagtgcc tatcgggtac tggttacttta agagtcggag gtgaatttgc 180
 ttgcaaggca ctatcacgag cgcactatct acatcccaca accaacctgg ggaaatcacc 240
 caaaagtctt caccctatct ggottgaacg ttaggagcta ccgctattat gatcctgca 299

<210> 346
 <211> 267
 <212> DNA
 <213> Zea mays

<400> 346

ctcgagccgc ggtctggctg aattcaataa gctgagcgct aagcttatct ttggcgctga 60
 cagccctgct attcaggaga ataggggttc taccgtgcag tgectatcgg gtactggttc 120
 tttaagagtc ggaggtgaat ttcttgcaag gcactatcac gagcgacta tctacatccc 180
 acaaccaacc tggggaaatc acccaaaagt cttcaccccta tctggcttga acgttaggag 240
 ctaccgctat tatgatcctg caacatg 267

<210> 347

<211> 269
 <212> DNA
 <213> Zea mays

<400> 347

ctcgaatcgt tccccacccat ggcgctgcag ggatcctccg tcttcgccgc actcgagcag 60
 gccccggagg accccatcct cggagtgacc gttgcctaca acaaggatcc cagccccgtg 120
 aaggtaacc tcggggtcgg cgctaccgg accgaggaag ggaagcccct agtgctgaac 180
 gtggtcaggc gcgcgcagca aatgttgatc aataatccgt cacgtgtcaa ggagtaccta 240
 ccaatcaccg gtctggctga attcaataa 269

<210> 348
 <211> 294
 <212> DNA
 <213> Zea mays

<400> 348

gcagcagaca cctccgccac ctccaccctc gaatcggttc ccaccatggc gtcgcaggga 60
 tcctccgtct tcgcgcact cgagcaggcc ccggaggacc ccatcctcgg agtgaccgtt 120
 gcctacaaca aggatcccag ccccggtgaag gtcaacctcg gggtcggcgc ctaccggacc 180
 gaggaaggga agcccctagt gctgaacgtg gtcaggcgcg ccgagcaaatt gttgatcaat 240
 aatccgtcac gtgtcaagga gtacctacca atcaccggtc tggctgaatt cata 294

<210> 349
 <211> 264
 <212> DNA
 <213> Zea mays

<400> 349

agcagacacc tccgccacct ccaccctcga atcggtcccc accatggcgt cgcagggatc 60
 ctccgtcttc gccgcactcg agcaggcccc ggaggacccc atcctcggag tgaccgttgc 120
 ctacaacaag gatcccagcc ccgtgaaggt caacctcggg gtcggcgcct accggaccga 180
 ggaagggaag cccctagtgc tgaacgtggt caggcgcgcc gagcaaattg tgatcaataa 240
 tccgtcacgt gtcaaggagt acct 264

<210> 350

<211> 304
 <212> DNA
 <213> Zea mays

 <400> 350

 cagacacctc cgccacctcc accctcgaat cgttccccac catggcgctcg cagggatcct 60
 ccgtcttcgc cgcactcgag caggcccccg tagaccccat cctcggagtg accgttgcct 120
 acaacaagga tcccagcccc atgaagggtca acctcgggggt tggcgccctac cggaccgagg 180
 aagggaagcc cctagtgtctg aacgtgggtca ggcgcgccga gcaaattgtg atcaataatc 240
 cgtcacgtgt caaggagtac ctaccaatca ccgggtctggc tgaattcaat aagctgagcg 300
 ctaa 304

<210> 351
 <211> 284
 <212> DNA
 <213> Zea mays

 <400> 351

 gcagcagaca cctctcccac ctccaccctc gaatcgttcc ccaccatggc gtcgcaggga 60
 tcctccgtct tcgccgaact cgagcaggcc ccggaggacc ccattctcgg agtgaccgtt 120
 gcctacaaca aggatcccag ccccggtgaag gtcaacctcg gggtcggcgc ctaccggacc 180
 gaggaaggga agcccctagt gctgaacgtg gtcaggcgcg ccgagcaaatt gttgatcaat 240
 aatccgtcac gtgtcaagga gtacctacca atcaccggtc tggc 284

<210> 352
 <211> 291
 <212> DNA
 <213> Zea mays

 <223> unsure at all n locations
 <400> 352

 cagacaccac cgccacctcc ancctcgaat cgttccccac catggcgctcg cagggatcct 60
 ccgtcttcgc cgcactcgag caggcccccg aggaccccat cctcggagtg accgttgcct 120
 acaacaagga tcccagcccc gtgaagggtca acctcgggggt cggcgccctac cggaccgagg 180
 aagggaagcc cctagtgtctg aacgtagtca ggcgcgccga gcaaattgtg atcaataatc 240
 cgtcacgtgt caaggagtac ctaccaatca ccgggtctggc tgaattcaat a 291

<210> 353
 <211> 281
 <212> DNA
 <213> Zea mays

 <400> 353

 gcagcagaca cctcgccacc tccaccctcg aatcgttccc caccatggcg tcgcagggat 60
 cctccgtctt cgccgcactc gagcaggccc cggaggaccc catcctcgga gtgaccgttg 120
 cctacaacaa ggatcccagc cccgtgaagg tcaacctcgg ggtcggcgcc taccggaccg 180
 aggaagggaa gcccctagtg ctgaacgtgg tcaggcgcg cagagcaaatg ttgatcaata 240
 atccgtcacg tgtcaaggag tacctaccaa tcaccggtct g 281

<210> 354
 <211> 247
 <212> DNA
 <213> Zea mays

 <400> 354

 cagcagacac ctccgccacc tccaccctcg aatcgttccc caccatggcg tcgcagggat 60
 cctccgtctt cgccgcactc gagcaggccc cggaggaccc catcctcgga gtgaccgttg 120
 cctacaacaa ggatcccagc cccgtgaagg tcaacctcgg ggtcggcgcc taccggaccg 180
 aggaagggaa gcccctagtg ctgaacgtgg tcaggcgcg cagagcaaatg ttgatcaata 240
 atccgtc 247

<210> 355
 <211> 266
 <212> DNA
 <213> Zea mays

 <400> 355

 gccacctoca tctcgaatc gttccccacc atggcgctcg agggatcctc cgtcttcgcc 60
 gcactcgagc aggccccgga ggaccccatc ctcgagtgga ccgttgcccta caacaaggat 120
 cccagccccg tgaagggtcaa cctcgggggtc ggcgcctacc ggaccgagga agggaagccc 180
 ctagtgctga acgtgggtcag gcgcgcccag caaatgttga tcaataatcc gtcacgtgtc 240
 aaggagtacc taccaatcac ggtctg 266

<210> 356
 <211> 274
 <212> DNA
 <213> Zea mays

 <400> 356

 cagcagacac ctccgccacc tccacctcg aatcggtccc caccatggcg tcgacaggat 60
 cctccgtctt cgccgcactc gagcaggccc cggaggaccc catcctcgga gtgaccgttg 120
 cctacaacaa ggatcccagc cccgtgaagg tcaacctcgg ggtcggcgcc taccggaccg 180
 aggaagggaa gccctagtgt ctgaacgtgg tcaggcgcg cagagcaaata ttgatcaata 240
 atccgtcacg tgtcaaggag tacctaccaa tcac 274

<210> 357
 <211> 299
 <212> DNA
 <213> Zea mays

 <400> 357

 gtgcgcgctg cgcaggcgca ggccccagc gccgaccgca gattaagtac gctagtgggg 60
 cacctgctgc ctctctcccc acgaagagca gcagcagaca cctccgccac ctccacctc 120
 gaatcggttc ccaccatggc gtgcgaggga tcttcgtct tcgccgact cgagcaggcc 180
 ccggaggacc ccattcctcg agtgaccgtt gctacaaca acgatcccag ccccgtaac 240
 gtcaacctcg gggtcggcg ctagcgacc gaggaaggga agcccctagt gctgaacgt 299

<210> 358
 <211> 251
 <212> DNA
 <213> Zea mays

 <400> 358

 cagacacctc cgccacctcc accctogaat cgttccccac catggcgctg caaggatcct 60
 ccgtcttcgc cgactcgag caggcacogg aggacaccat cctcggagtg accgttgctt 120
 acaacaagga tcccagcccc gtgaagggtc acctcggggg cggcgccctac cggaccgagg 180
 aagggaagcc cctagtgtgt aacgtgggtc ggcgcgccga gcaaagtgtg atcaataatc 240
 cgtcacgtgt c 251

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<210> 359
<211> 237
<212> DNA
<213> Zea mays

<400> 359

ctgacgcgtg gctggaacgc tggggcagca gacacctccg ccacctccac cctcgaatcg 60
taccacacca tggcgtcgca tggatcctcc gtcttcgccg cactcgagca ggccccggag 120
gaccccatcc tcggagtgcg cgttgccctac aacaaggatc ccagccccgt gaaggtcaac 180
ctcgggggtcg gcgcctaccg gaccgaggaa ggggaagcccc tagtgctgaa cgtgggtc 237

<210> 360
<211> 175
<212> DNA
<213> Zea mays

<400> 360

tgcgcctacc ggaccgacga aggggaagccc tagtgctgaa cgtgggtcagg cgcgccgagc 60
aaatgttgat caataatccg tcacgtgtca aggagtacct accaatcacc ggtctgggtc 120
aattcaataa gctgagcgct aagcttatct ttagcgctga cagccctgct attca 175

<210> 361
<211> 447
<212> DNA
<213> Zea mays

<223> unsure at all n locations
<400> 361

agctgcttta gcgtactaac tcgnaatcga ctcgacagca cagacacctc cgccacctcc 60
actctcgaat cgttcccacc atggcgtcgc agcngatcct cgcgtcattc gcacgcagct 120
cgagcgaggc actcgggagg gacncgcatg cctccggacg tnggaccgta tgactacat 180
gacataagga tccccagct cccagtgena ngggtaacc attcggnggt cggcggcctt 240
acgtcggacc gaggaaggg aagctcctag tgctgaacgt ggtcaggcgc gccgagcana 300
tgttgatcaa taatccgtca cgtgtcaagg agtacctaca atcacagtca tgctgaattc 360
ataactgacg ctaacttatc ttgcgtgaca gctgctatca gagataggtc tacgtcatgc 420

tacggtctgt cttagatcga gtgatct

447

<210> 362
<211> 274
<212> DNA
<213> Zea mays

<400> 362

gacacctccg ccacctccac cctcgaatcg ttccccacca tggcgtcgca gggatcctcc 60
gtcttcgccg cactcgagca ggccccggag gaccccatcc tcggagtgcg cgttgcctac 120
aacaaggatc ccagccccgt gaaggtcaac ctcggggtcg ggcgctaccg gaccgaggaa 180
gggaagcccc tagtgctgaa cgtgggtcagg cgcgcgagc aaatgttgat caataatccg 240
tcacgtgtca aggagtacct accaatcacc ggtc 274

<210> 363
<211> 163
<212> DNA
<213> Zea mays

<223> unsure at all n locations
<400> 363

cagcagcaga cacctccgcc acctccaccc tcgaatcggt cccaccatg gcgtgctcgg 60
atcctccgtc ttgcgcgcac tcgagcaggc cccggaggac cccatcctcg gtctcancgt 120
tgcctacaac aaggatccca gccccgtgaa ggtcaacctc ggg 163

<210> 364
<211> 280
<212> DNA
<213> Zea mays

<400> 364

tgacactccg ccacctccac cctcgaatcg ttccccacta tggcgtcgca gggatcctcc 60
gtcttcgccg cactcgagca ggccccggag gaccccatcc tcggagtgcg cgttgcctac 120
aacaagggat ccagccccgt gaaagtcaac ctcggggggtc ggcgctaacg gaaccgagga 180
agggaacccc tagtgctgaa cgtgttaagc gcgcgagcaa tgttgatcat aatcgtcagt 240
gtcaggagta ctaccatcac gttctgctga atcatagctg 280

<210> 365
 <211> 128
 <212> DNA
 <213> Zea mays

<223> unsure at all n locations
 <400> 365

ctcgaatcgt tcnccacccat ggogtgcag ggatcctccg tcttcgccgc actcgagcag 60
 gcaccggagg actccatcct cggagtgcac gttgcctaca acaaggatcn cagccccgtg 120
 aaggtcaa 128

<210> 366
 <211> 183
 <212> DNA
 <213> Zea mays

<400> 366

gcagacacct ccgccacatc cacactcgaa tcgttcccca ccatggcgtc gcagggatcc 60
 tccgtcttcg ccgcactcga gcaggccccg gaggacacca tctcggagt gaccgttgcc 120
 tacaacaagg atcccagccc cgtgaacgtc aacctcgagg tcggcgcta caggaccgag 180
 gaa 183

<210> 367
 <211> 324
 <212> DNA
 <213> Zea mays

<400> 367

cccacgcgtc cgggcggaga catgggtagc ttcgctaagc tggcgaggag ggcggtggag 60
 acggacgctc cggatcatggt gaagatacaa gaactgctcc gagggggcaa ggatgtgatg 120
 tcgcttgccg agggagttgt ttactggcaa cctcccagat cagctatgga taagatcgaa 180
 aagatcatca gggaaccaat agtcagtaaa tatggttctg atgatgggct tctgagctt 240
 cgagaagcac ttctcgaaaa gctaagcaga gagaacaagc ttaccaaata atcagtcatg 300
 gtcactgctg gtgcaaatca ggct 324

<210> 368
 <211> 327
 <212> DNA

<213> Zea mays

<400> 368

gtgccaatgg ctctccaga cccaattctt ggggtttctg aggcctttaa agcagataaa 60
agcgagctga agctcaatct tgggtgttgg gcctatagga cagaagagct gcagccctac 120
gtgctcaatg tagtcaagaa ggctgaaaat ottatgttgg agaaaggaga aaacaaagag 180
tatcttccca ttgaagggtt agccgcgttt aacaaagcaa cagcagagct attgcttgga 240
gctgataacc ctgttattaa tcaaggactg gttgctacac ttcagtctct ctggggcact 300
ggatcactgc gtctcgtctgc agcatto 327

<210> 369

<211> 318

<212> DNA

<213> Zea mays

<400> 369

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ttcatacaaa gatactttcc tgaagctaaa gtgctgatat cgtcgcctac ctggggtaac 180
cacaagaata tcttcaatga tgctagggtg ccttgggtcag agtacaggta ctatgacccc 240
aagactgttg ggttggtatt tgaggaatg atagctgata ttgaggtctg tctgaagga 300
tcttttgttc tgctacat 318

<210> 370

<211> 319

<212> DNA

<213> Zea mays

<400> 370

agagctgcag ccctacgtgc tcaatgtagt caagaaggct gaaaatctta tgttggagaa 60
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agagctattg cttggagctg ataaccctgt tattaatcaa ggactgggtg ctacacttca 180
gtctctctcg ggcaactggat cactgcgtct cgctgcagca ttcatacaaa gatactttcc 240
tgaagctaaa gtgctgatat cgtcgcctac ctggggtaac cacaagaata tcttcaatga 300

tgctagggtta ccttgggtca

319

<210> 371
<211> 301
<212> DNA
<213> Zea mays

<400> 371

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agggaaatgat agctgatatt gaggctgctc ctgaaggatc ttttgttctg ctacatgggt 180
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g 301

<210> 372
<211> 264
<212> DNA
<213> Zea mays

<400> 372

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tggtttgtgct cacaacccaa ctggaataga cccaactcct gaacagtggg agaaaattgc 120
agatgtcatt caagagaaaa agcatatgcc attctttgat gttgcatatc aaggttttgc 180
cagtggaaagc cttgatgaag atgcattttc tgtcaggctt tttgttaagc gtggcatgga 240
agtgtttgtt gcacaatctt acag 264

<210> 373
<211> 293
<212> DNA
<213> Zea mays

<400> 373

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ggtgcctata ggacagaaga gctgcagccc tacgtgctca atgtagtcaa gaaggctgaa 120
aatcttatgt tggagaaagg agaaaacaaa gagtatcttc ccattgaagg tttagccgcg 180

tttaacaaag caacagcaga gctattgctt ggagctgata acctgttat taatcaagga 240
 ctggttgcta cacttcagtc tctctcgggc actggatcac tgcgtctcgc tgc 293

<210> 374
 <211> 285
 <212> DNA
 <213> Zea mays

<400> 374

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 tacatgggtt tgctcacaac ccaactggaa tagaccaac tcctgaacag tgggagaaaa 120
 ttgcagatgt cattcaagag aaaaagcata tgccattctt tgatgttgca tatcaggggt 180
 ttgccagtgg aagccttgat gaagatgcat tttctgtcag gctttttgtt aagcgtggca 240
 tggaagtgtt tgttgcacaa tcttacagca agaaccttgg tttat 285

<210> 375
 <211> 275
 <212> DNA
 <213> Zea mays

<400> 375

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 tattaatcaa ggactgggtt ctacacttca gtctctctcg ggcaactggat cactgcgtct 180
 cgctgcagca ttcatacaaa gatactttcc tgaagctaaa gtgctgatat cgtcgcctac 240
 ctggggtaac cacaagaata ttttcaatga tgcta 275

<210> 376
 <211> 268
 <212> DNA
 <213> Zea mays

<400> 376

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 ccatacgtgc tcaatgtagt caagaaggct gaaaatctta tgttggagaa aggagaaaac 120
 aaagagtatc ttcccattga aggttttagcc gcgtttaaca aagcaacagc agagctattg 180

cttggagctg ataaccctgt tattaatcaa ggactggttg ctacacttca gtctctctcg 240
ggcactggat cactgcgtct cgctgcag 268

<210> 377
<211> 261
<212> DNA
<213> Zea mays

<400> 377

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aacaaagagt atcttccat tgaaggttta gccgcgttta acaaagcaac agcagagcta 180
ttgcttgag ctgataaacc tgttattaat caaggactgg ttgctacact tcagtctctc 240
tcgggcactg gatcactgcg t 261

<210> 378
<211> 261
<212> DNA
<213> Zea mays

<400> 378

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ttgcagatgt cattcaagag aaaaagcata tgccattctt tgatgttgca tatcagggtt 180
ttgccagtgg aagccttgat gaagatgcat tttctgtcag gctttttgtt aagcgtggca 240
tggaagtgtt tgttgcacaa t 261

<210> 379
<211> 247
<212> DNA
<213> Zea mays

<400> 379

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aaagcgagct gaagctcaat cttggtgttg gtgcctatag gacagaagag ctgcagccct 120
acgtgctcaa thtagtcaag aaggctgaaa atcttatgtt ggagaaagga gaaaacaaag 180

agtatcttcc cattgaaggt ttagccgcgt ttaacaaagc aacagcagag ctattgcttg 240
gagctga 247

<210> 380
<211> 293
<212> DNA
<213> Zea mays

<400> 380

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tttagccgcg ttttaacaaag caacagcaga gctattgctt ggagctgata accctgttat 120
taatcaagga ctggttgcta cacttcagtc tctctcgggc actggatcac tgcgtctcgc 180
tgcagcattc atacaaagat actttcctga agctaaagtg ctgatatcgt cgcctacctg 240
gggtaaccac aagaatatct tcaatgatgc ttagggacct tggtcagagt aca 293

<210> 381
<211> 281
<212> DNA
<213> Zea mays

<400> 381

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agaaaggaga aaacaaagag tatcttccca ttgaaggttt agccgcgttt aacaaagcaa 120
cagcagagct attgcttgga gctgataacc ctgttattaa tcaaggactg gttgctacac 180
ttcagtctct ctcgggcact ggatcacagc gtctcgtcgc agcattcata caaagatact 240
ttcctgaagc taaagtgctg atatcgtcgc ctacctgggg t 281

<210> 382
<211> 262
<212> DNA
<213> Zea mays

<400> 382

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acagcagagc tattgcttgg agctgataac cctgttatta atcaaggact ggttgctaca 120
cttcagtctc tctcgggcac tggatcactg cgtctcgtcgc cagcattcat acaaagatac 180

tttcctgaag ctaaagtgct gatatcgctg cctacctggg gtaaccacaa gaatatcttc 240
aatgtgctag ggtacttggt ca 262

<210> 383
<211> 278
<212> DNA
<213> Zea mays

<400> 383

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tacatggttg tgatcacaac ccaactggaa tagaccaaac tcctgaacag tgggagaaaa 120
ttgcagatgt cattcaagag aaaaagcata tgccattctt tgatgttgca tatcagggtt 180
aggtcagtgg aagccttgat gaagatgcat tttctgtcag gctttttgtt agcgtagcat 240
ggaagtgttt gttgcacaat cttacagcaa gaacttgg 278

<210> 384
<211> 180
<212> DNA
<213> Zea mays

<400> 384

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tacatggttg tgctcacaac ccaactggaa tagaccaaac tcctgaacag tgggagaaaa 120
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<210> 385
<211> 210
<212> DNA
<213> Zea mays

<400> 385

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cagatgtcat tcaagagaaa aagcatatgc cattcttgga tgttgcatat cagggttttg 120
ccagtggaag ccttgatgaa gatgcatttt ctgtcaggct ttttgtttaag cgtggcatgg 180
aagtgtttgt tgcacaatct tacagcaaga 210

<210> 386

<211> 292
 <212> DNA
 <213> Zea mays

<400> 386

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 gtgatccaga gagagatgcc aaggcaatcc gaattttcct tgaagatgga caccaaattg 180
 gatgtgctca gtcatacgca aagaacatgg gactttatgg acagagagca ggatgcctga 240
 gtattctgtg tgaggatgag atgcaagcag ttgctgtcaa gagccaactg ca 292

<210> 387
 <211> 290
 <212> DNA
 <213> Zea mays

<400> 387

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 ccttgaagat ggacaccaa ttggatgtgc tcagtcatac gcaaagaaca tgggacttta 120
 tggacaaaga gcaggatgcc tgagtatttt gtgtgaggat gagatgcaag cagttgctgt 180
 caagagccaa atgcaacaga tcgcaagacc aatgtacagc aaccacactg ttcattggtgc 240
 actggttgtc tctataatcc tcagtgtacc agaattgaag agttgtggtt 290

<210> 388
 <211> 281
 <212> DNA
 <213> Zea mays

<400> 388

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 aacaatggag agatatatcc catcagttca aggtgaaaaa acattttcca ttctttgaca 120
 tggcatacca agggtttgcc agtgggtgatc cagagagaga tgccaaggca atccgaattt 180
 tccttgaaga tggacaccaa attggatgtg ctcaagcata cgcaaagaac atgggacttt 240
 atggacaaag agcaggatgc ttgagtattt tgtgtgaaga t 281

<210> 389

<211> 175
 <212> DNA
 <213> Zea mays

<400> 389

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 aacaatggag agaaatatcc catcagttca aggtgaaaaa acattttcca ttctttgaca 120
 tggcatacca agggtttgcc agtgggtgatc cagagagaga tgccaaggca atccg 175

<210> 390
 <211> 136
 <212> DNA
 <213> Zea mays

<400> 390

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 atacgcaaag aacatg 136

<210> 391
 <211> 181
 <212> DNA
 <213> Zea mays

<400> 391

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 aacaatggag agaaatatcc catcagttca aggtgaaaaa acattttcca ttctttgaca 120
 tggcatacca agggtttgcc agtgggtgatc cagagagaga tgccaaggca atccgaattt 180
 c 181

<210> 392
 <211> 177
 <212> DNA
 <213> Zea mays

<400> 392

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gcataccaag ggtttgccag tggatgatcca gagagagatg ccaaggcgat ccgaatt 177

<210> 393
<211> 259
<212> DNA
<213> Zea mays

<400> 393

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catagtctat gattctgctt atgcaatgta catatcagat gacagcccaa agtctatctt 180
tgaaattcct ggagcaaagg aggttgctat tgagacagcc tcattctcga agtacgctgg 240
gttcacaggt gtccgtcta 259

<210> 394
<211> 343
<212> DNA
<213> Zea mays

<400> 394

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ggagctcctt ttctcggatg gacatccagt tgctaaagat ttcaatcgca tagtttgac 180
ttgcttcaat gggcatcaaa cattgcgcaa ctgggtggtt agcctgcctc tctccagacg 240
gtctaaaggc tatgcaagat gttgttggt tctacaagga gaacactgaa ataatcgttg 300
agacatttac atcactcggg ttcgacgtct atggcgcaaa gac 343

<210> 395
<211> 171
<212> DNA
<213> Zea mays

<223> unsure at all n locations
<400> 395

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cttttctcgg atggacatcc agttgctana gatttcaatc gcatagtttg c 171

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1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	

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<223>      unsure at all n locations
<400>      397
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gttcctttgac	agtgcctatc	aaggctttgc	aagtggaaagt	cttgacaaaag	atgctcagtc	180
agtgcgtatg	tttgttgctg	atggtgggtga	acttctcatg	gctcagagct	acgctaagaa	240
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<223>      unsure at all n locations
<400>      398
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137

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<210> 399
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 <213> Zea mays
 <400> 399

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<210> 400
 <211> 269
 <212> DNA
 <213> Zea mays
 <400> 400

<210> 401
 <211> 318
 <212> DNA
 <213> Zea mays

<223> unsure at all n locations
 <400> 401

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 ccagangaac ccctggtg 318

<210> 402
 <211> 282
 <212> DNA
 <213> Zea mays
 <223> unsure at all n locations
 <400> 402

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 ctttcaggtt caattgtact gctgcatgcc tgtgctcaca accctactgg agtagatcct 180
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 tttgacagt cctatcaagg ctttgcaagt ggaagtcttg ac 282

<210> 403
 <211> 260
 <212> DNA
 <213> Zea mays
 <400> 403

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 gaaagtcaac tcaaacttgt catcaggcct atgtattcaa accctcctct tcatggtgcc 180
 tctatcgttg ctaccatact cagggaacgc gagatgttca acgaatggac tctggaactg 240
 aaggccatgg ctgataggat 260

<210> 404
 <211> 302
 <212> DNA
 <213> Zea mays
 <400> 404

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 ttgcaaggca ctatcacgag cgcactatct acatcccaca accaacctgg ggaaatcacc 120

caaaagtctt caccctatct ggcttgaacg ttaggagatg aacgctatta tgatcctgca 180
 acatgcagcc ttcacttcga aggactcctg gaagacctcg gttctgctcc ttcaggttca 240
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 tg 302

<210> 405
 <211> 280
 <212> DNA
 <213> Zea mays
 <223> unsure at all n locations
 <400> 405

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 acttgtcatc aggcctatgt attcaaacc tctcttcat ggtgcctcta tcgttgctac 180
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 taggntctta acatgaggca acaactatth aatgogctga 280

<210> 406
 <211> 264
 <212> DNA
 <213> Zea mays
 <400> 406

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 tgtcatcagg ccatgtattc aaaccctcct cttcatggtg cctctatcgt tgctaccata 180
 ctcagggaca gcgagatggt caacgaatgg actctggaac tgaaggccat ggctgatagg 240
 atcattaaca tgaggcaaca actt 264

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 <212> DNA
 <213> Zea mays
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agccatatca ttaagcaa at tgggatgttt acttttactg ggctgaatag cgaacaagtc 180
gcattcatga ggcaggaata ccacatttat atgacatctg atgggaggat cagcatggcc 240
ggtttgagca tg 252

<210> 408
<211> 254
<212> DNA
<213> Zea mays

<400> 408

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gaggcaacaa ctattttaatg cgctgaaatc cagaggaacc cctgggtgatt ggagccatat 120
cattaagcaa attgggatgt ttactttcac tgggctgaat agcgaacaag tcgcattcat 180
gaggcaggaa taccacattt atatgacatc tgatgggagg atcagcatgg ccggtttgag 240
catgaggact gtgc 254

<210> 409
<211> 254
<212> DNA
<213> Zea mays

<400> 409

gtaaaagtgc cgatgtagct gttagggttg aaagtcaact caaacttgtc atcaggccta 60
tgtattcaaa ccctcctctt catggtgcct ctatcgttgc taccatactc agggacagcg 120
agatgttcaa cgaatggact ctggaactga aggccatggc tgataggatc attaacatga 180
ggcaacaact atttaatgcg ctgaaatcca gaggaacccc tggtgattgg agccatatca 240
ttaagcaa at tggg 254

<210> 410
<211> 255
<212> DNA
<213> Zea mays

<400> 410

ctgttaggggt tgaaagtcaa ctcaaacttg tcatcaggcc tatgtattca aaccctcctc 60
 ttcatgggtgc ctctatcggt gctaccatac tcaggacag cgagatgttc aacgaatgga 120
 ctctggaact gaaggccatg gctgatagga tcattaacat gaggcaacaa ctatttaatg 180
 cgctgaaatc cagaggaacc cctgggtgatt ggagccatat cattaagcaa attgggatgt 240
 ttactttcac tgggc 255

<210> 411
 <211> 235
 <212> DNA
 <213> Zea mays

<400> 411

gattaggcag ctgatgagat caaaatcaact gcttccgttc ttgacagtg cctatcaagg 60
 ctttgcaagt ggaagtcttg acaaagatgc tcagtcagtg cgtatgtttg ttgctgatgg 120
 tgggtgaactt ctcatggctc agagctacgc taagaacatg ggattgtatg gagagcgtgt 180
 tggcgctttg agcattgtat gtaaaagtgc cgatgtagct gttagggttg aaagt 235

<210> 412
 <211> 272
 <212> DNA
 <213> Zea mays

<223> unsure at all n locations
 <400> 412

acttctcatg gctcagagct acgctaagaa catgggattg tatggagagc gtgttggcgc 60
 tttgagcatt gtatgtaaaa gtgccgatnt agctgtagg gttgaaagtc aactcaaact 120
 tgtcancagg cctatgtatt caaaccctcc tcttcatggg gctctatcg ttgctaccat 180
 annncaggac agcgagatgt tcaacgaatg gactctggaa tgaaggccat ggctgatagg 240
 atcataacat gaggcaacaa ctattaatgc gc 272

<210> 413
 <211> 243
 <212> DNA
 <213> Zea mays

<400> 413

caggcctatg tattcaaacc ctctcttca tgggtgctct atcgttgcta ccatactcag 60

ggacagcgag atgttcaacg aatggactct ggaactgaag gccatggctg ataggatcat 120
 taacatgagg caacaactat ttaatgcgct gaaatccaga ggaaccctg gtgattggag 180
 ccatatcatt aagcaaattg ggatgtttac tttcactggg ctgaatagcg aacaagtcgc 240
 att 243

<210> 414
 <211> 241
 <212> DNA
 <213> Zea mays

<400> 414

gtcttgacaa agatgctcag tcagtgcgta tgtttgttgc tgatgggtgg gaacttctca 60
 tggctcagag ctacgctaag aacatgggat tgtatggaga gcggtgttggc gctttgagca 120
 ttgtatgtaa aagtgccgat gtagctgtta gggttgaaag tcaactcaaa cttgtcatca 180
 ggcctatgta ttcaaaccct cctcttcatg gtgcctctat cgttgctacc atactcaggg 240
 a 241

<210> 415
 <211> 254
 <212> DNA
 <213> Zea mays

<400> 415

tgagaagttc accaccatca gcaacaaaca tacgcaactga ctgagcatct ttgtcaagac 60
 ttccacttgc aaagccttga taggcactgt caaagaacgg aagcagtgat tttgatctca 120
 tcagctgcct aatctgttcc cactgttcga tggtaggata tactccagta gggttgtgag 180
 cacaggcatg cagcagtaca attgaacctg aaggagcaga accgaggtct tccaggagtc 240
 cttogaagtg aagg 254

<210> 416
 <211> 221
 <212> DNA
 <213> Zea mays

<400> 416

gattaggcag ctgatgagat caaaatcact gcttccgttc tttgacagtg cctatcaagg 60

ctttgcaagt ggaagtcttg acaaagatgc tcagtcagtg cgtatgtttg ttgctgatgg 120
 tgggtgaactt ctcatggctc agagctacgc taagaacatg ggattgtatg gagagcgtgt 180
 tggcgctttg agcattgtat gtaaaagtgc cgatgtagct g 221

<210> 417
 <211> 328
 <212> DNA
 <213> Zea mays

<400> 417

ctagttctag atcgccagcc gccgctcggg ccgctcgatc tagaactagc ccacgcgtcc 60
 gcggacgcgt ggcacgagcg cactatctac atcccacaac caatcctggg gaaatcaccc 120
 aaaagtcttc acactatctg gcttgaacgt taggagctac cgtattatg atcctgcaac 180
 atgcagcctt cacttcgaag gactcctgga acacctcggg tctgctcctt caggttcaat 240
 tgtactgctg catgcctgtg ctcaacaacc tactggagta gatcctacca tcgaacagtg 300
 ggaacagatt aggcagctga tgagatca 328

<210> 418
 <211> 272
 <212> DNA
 <213> Zea mays

<400> 418

atatcattaa gcaaattggg atgtttactt tcactgggct gaatagcgaa caagtcgcat 60
 tcatgaggca ggaataccac atttatatga catctgatgg gaggatcagc atggccggtt 120
 tgagcatgag gactgtgccc catcttgtag atgccatata cgctgcagtt actcaactga 180
 aatgaggata gtatcgtagc tttcgtgaat aaaacctgaa tcaccacaaa caatgttcta 240
 agtactcagc cagtgggtatc tactggttga cc 272

<210> 419
 <211> 249
 <212> DNA
 <213> Zea mays

<223> unsure at all n locations
 <400> 419

cggaacgctg gtntaatgc gctgaaatcc agaggaaccc ctggtgattg gagccatata 60
aanaagcaaa ttgggatggt tacttttact gggctgaata gcgaacaagt cgcattcatg 120
aggcaggaat accacattta tatgacatct gatgggagga tcagcatggc cggtttgagc 180
atgaggactg tgccccatct tgcagatgcc atacacgctg cagttactca actgaaatga 240
ggatagtat 249

<210> 420
<211> 224
<212> DNA
<213> Zea mays

<400> 420

gcgagatggt caacgaatgg actctggaac tgaaggccat ggctgatagg atcattaaca 60
tgaggcaaca actatttaat gcgctgaaat ccagaggaac ccttggtgat tggagccata 120
tcattaagca aattggatgt ttactttcac tgggctgaat agcgaacaag tcgcattcat 180
gaggcaggaa taccacattt atatgacatc tgatgggagg atca 224

<210> 421
<211> 234
<212> DNA
<213> Zea mays

<400> 421

atccagagga acccctggtg attggagcca tatcattaag caaattggga tgtttacttt 60
cactgggctg aatagcgaac aagtcgcatt catgaggcag gaataccaca tttatatgac 120
atctgatggg aggatcagca tggccggttt gagcatgagg actgtgcccc atcttgacaga 180
tgccatacac gctgcagtta ctcaactgac atgaggctag tatcgcagct ttcg 234

<210> 422
<211> 280
<212> DNA
<213> Zea mays

<400> 422

gggttgctac cgtgcagtgc ctatcgggta ctggttcttt aagagtcgga ggtgaatttc 60
ttgcaaggca ctatcacgag cgcactatct acatcccaca accaacctgg ggaaatcacc 120

caaaagtctt caccctatct ggcttgaacg ttaggagcta ccgctattat gatcctgcaa 180
catgcagcct tcaacttcgaa ggactcctgg aaagactcgg ttctgctact tcaggttcat 240
tgtactgctg catgcctgtg ctcacaacct actggagtag 280

<210> 423
<211> 278
<212> DNA
<213> Zea mays

<400> 423

gtgaaatcca gaggaacccc tgggtgattgg agccatatca ttaagcgaat tgggatgttt 60
actttcactg ggctgaatag cgaacaagtc gcattcatga ggcaggaata ccacatttat 120
atgacatctg atgggaggat cagcatggcc ggtttgagca tgaggactgt gccccatctt 180
gcagatgcca tacacgtgc agttactcaa ctgaaatgag gatagtatcg cagctttcgt 240
gaataaaaacc tgaatcacco acaacaatgt tctaagta 278

<210> 424
<211> 229
<212> DNA
<213> Zea mays

<223> unsure at all n locations
<400> 424

ggaggtgaat ttcttgcaag gcaactatcac gagcgcacta tctacatccc acaaccaacc 60
tggggaaatc acccaaaagt cttcacccta tctggcttga acgttaggng ctaccgctat 120
tatgatcctg caacatgcag ccttcacttc gaaggactcc tggaagacct cggttctgct 180
ccttcaggtt caattgtact gctgcatgcc tgtgtctaca accctactg 229

<210> 425
<211> 268
<212> DNA
<213> Zea mays

<400> 425

aagtcgcatt catgaggcag gaataccact ttatatgaca tctgatggga ggatcagcat 60
ggccgggtttg agcatgagga ctgtgcccc a tottgcatg gccatacacg ctgcagttac 120
tcaactgaaa tgaggatagt atcgcagctt tcgtgaataa aacctgaatc acccacaaca 180

atgttctaag tactcagcca gtggtattta ctggttgacc tactgtagtt tgcgtcggaa 240
tagatatgtt tttttactct tcgtgggg 268

<210> 426
<211> 279
<212> DNA
<213> Zea mays

<400> 426

cccctggtga ttggagccat atcattaagc aaattgggat gtttactttc actgggctga 60
atagcgaaca agtcgcattc atgaggcagg aataccacat ttatatgaca tctgatggga 120
ggatcagcat ggccggtttg agcatgagga ctgtgcccc tcttgcatg gccatacacg 180
ctgcagttac tcaactgaaa tgaggatagt atcgcagctt tcgtgaataa aacctgaatc 240
accacaaca atgttctaag tactcagcca gtggtattt 279

<210> 427
<211> 209
<212> DNA
<213> Zea mays

<400> 427

gtcttgacaa agatgctcag tcagtgcgta tgtttgttgc tgatggtggt gaacttctca 60
tggctcagag ctacgctaag aacatgggat tgtatggaga gcgtgttggc gctttgagca 120
ttgtatgtaa aatgccgatg tagctgttag ggttgaaagt caactcaaac ttgtcatcag 180
gcctatgtat tcaaaccctc ctcttcatg 209

<210> 428
<211> 270
<212> DNA
<213> Zea mays

<400> 428

agcaaattgg gatgtttact ttactgggc tgaatagcga acaagtcgca ttcattgaggc 60
aggaatacca cttttatatg acatctgatg ggaggatcag catggccggg ttgagcatga 120
ggactgtgcc ccatcttgca gatgccatac acgctgcagt tactcaactg aaatgaggat 180
agtatcgcag ctttcgtgaa taaaacctga atcaccacaa acaatgttct aagtactcag 240

ccagtgggtat tactggttga cctactgtag

270

<210> 429
<211> 187
<212> DNA
<213> Zea mays

<400> 429

ctgaaatcca gaggaacccc tgggtgattgg agccatatca ttaagcaaat tgggatgttt 60
actttcactg ggctgaatag cgaacaagtc gcattcaatg aggcaggaat aaccacattt 120
atatgacatc tgatgggagg atcagcatgg ccggtttgag catgaggact gtgccccatc 180
ttcaaga 187

<210> 430
<211> 214
<212> DNA
<213> Zea mays

<400> 430

ttgggatgtt tactttcact gggtgaata gcgaacaagt cgcattcatg aggcaggaat 60
accacattta tatgacatct gatgggagga tcagcatggc cgggtttgagc atgaggactg 120
tgccccatct tgcagatgcc atacacgctg cagttactca actgacatga ggctagtatc 180
gcagctttcg tgaataaaac ctgaatcacc caca 214

<210> 431
<211> 188
<212> DNA
<213> Zea mays

<400> 431

tgtagctgtt aggattgaaa gtcaactcaa acttgtcatc aggcctatgt attcaaaccc 60
acctcatcat ggtgcctcta tcgtagctac catactcagc gacagcgaga tgttcaacga 120
atggacactg gaacagaagg ccatggctga taggatcatt aacatgaggc aacaactatt 180
taatgcgc 188

<210> 432
<211> 256

<212> DNA
<213> Zea mays

<400> 432

ctgaaatcca gaggaacccc ggtgattgga gccatatcat taagcaaatt gggatgttta 60
ctttcactgg gctgaatagc gaacaagtcg cattcatgag gcaggaatac cacatttata 120
tgacatctga tgggaggatc agcatggccg gtttgagcat gaggactgtg ccccatcttg 180
cagatgccat acacgtcgca gttactcaac tgaaatgagg atagtatcgc agctttcgtg 240
aataaacctg aatcac 256

<210> 433
<211> 263
<212> DNA
<213> Zea mays

<400> 433

tgagccatat cattaagcaa attgggatgt ttactttcac tgggctgaat agcgaacaag 60
tcgcattcat gaggcaggaa taccacattt atatgacatc tgatgggagg atcagcatgg 120
ccggtttgag catgaggact gtgacccatc ttgcagatgc catacacgct gcagttactc 180
aactgaaatg aggatagtat cgcagctttc gtgaataaaa cctgaatcac ccacaacaat 240
gttctaagta ctgagccagt ggt 263

<210> 434
<211> 241
<212> DNA
<213> Zea mays

<400> 434

atgacatctg atgggaggat cagcatggcc ggtttgagca tgaggactgt gccccatctt 60
gcagatgccca tacacgtctc agttactcaa ctgaaatgag gatagtatcg cagctttcgt 120
gaataaaaacc tgaatcacco acaacaatgt tctaagtact caaccagtgg tatttactgg 180
ttgacctact gtagtttgcg tcggaataga tatgtttttt tactcttcgt ggggcagttt 240
t 241

<210> 435
<211> 162

<212> DNA
<213> Zea mays

<400> 435

gtcaactcaa acttgtcatc aggcctatgt attcaaacc tcctcttcat ggtgcctcta 60
tcgttgctac catactcagg gacagcgaga tgttcaacga atggactctg gaactgaagg 120
ccatggctga taggatcatt aacatgaggg aacaactatt ta 162

<210> 436
<211> 151
<212> DNA
<213> Zea mays

<400> 436

ctcgagcgcg ctgaaatcca gaggaacccc tggtgattgg agccatatca ttaagcatat 60
tgggatgttt actttcactg ggctgaatag cgaacaagtc gcattcatga ggcaggaata 120
ccacatttat atgacatctg atgggaggat c 151

<210> 437
<211> 276
<212> DNA
<213> Zea mays

<400> 437

tgccggtttg agcatgagga ctgtgcccc tcttgagat gccatacacg ctgcagttac 60
tcaactgaaa tgaggatagt atcgcagctt tcgtgaataa aacctgaatc acccacaaca 120
atgttctaag tactcagcca gtggtattta ctggttgacc tactgtagtt tgcgtcggaa 180
tagatatgtt tttttactct tcgtggggca gttttgtact ggtggattca taaggactct 240
gattatggtg cgttcggaac ttataataat aagcac 276

<210> 438
<211> 112
<212> DNA
<213> Zea mays

<400> 438

ctgagatcaa aatcactgct tccgttcttt gacagtgcct atcaaggctt tgcaagtgga 60
agtcttgaca aagatgctca gtcagtgcgt atgtttgttg ctgatggtgg tg 112

<210> 439
 <211> 164
 <212> DNA
 <213> Zea mays

<400> 439

accacaaca atgttctaag tactcagcca gtggtattta ctggttgacc tactgtagtt 60
 tgcgtcggaa tagatatgtt tttttactct tcgtggggca gttttgtact ggtggattca 120
 taaggactct gattatgggtg cgttcggaac ttataataat aagc 164

<210> 440
 <211> 173
 <212> DNA
 <213> Zea mays

<400> 440

caatgttcta agtactcagc cagtgggtatt tactgggtga cctactgtag tttgcgtcgg 60
 aatagatatg tttttttact cttcgtgggg cagtgtttgta ctggtggatt cataaggact 120
 ctgattatgg tgcgttcgga acttataata ataagcacat gaaattttgc ttc 173

<210> 441
 <211> 173
 <212> DNA
 <213> Zea mays

<400> 441

caatgttcta agtactcagc cagtgggtatt tactgggtga cctactgtag tttgcgtcgg 60
 aatagatatg tttttttact cttcgtgggg cagtgtttgta ctggtggatt cataaggcct 120
 ctgattatgg tgcgttcgga acttataata ataagcacat gaaattttgc ttc 173

<210> 442
 <211> 429
 <212> DNA
 <213> Zea mays

<400> 442

atccgaattt tccttgaaga tggacaccaa attggatgtg ctgagtcata cccaagaac 60
 atgggacttt atggacaaag agcaggatgc ctgagtattt tgtgtgagga tgagatgcaa 120

gcagttgctg tcaagagcca actgcaacag atcgcaagac caatgtacag caaccacct 180
gttcatggtg cactggttgt ttctataatc ctcaagtatc cagaattgaa gagtttgtgg 240
ttaaaagaag tcaaggggat ggctgatcgt atcattggaa tgcggaaggc acttaaggaa 300
aatcttgaag agctagggtc acctttgtca tgggatcata tcactaatca gattggaatg 360
ttctgttaca gtgggatgac acctgaacaa gttgaccgtt taacaaatga ataccacatt 420
tacatgacc 429

<210> 443
<211> 325
<212> DNA
<213> Zea mays

<400> 443

tcgcaaacct ttcaattctg gatcaactgaa gagctggagg cacttaagga aaatctggaa 60
gagctagggt cacctttgtc atgtgatcat atcactaatc agattggaat gttctgtctac 120
agtgggatga cacctgaaca agtttaccgt ttaacaaatg aataccagag ttacattacc 180
cgtaatggga ggataagctt tgctggtgtt acgacaggat atgttgacta cctttcatat 240
gcaattcatg aggttaccaa accaaattga gttaggggtc taccttcttt ggtcgatgga 300
agctgatgga atgagactgt taagc 325

<210> 444
<211> 279
<212> DNA
<213> Zea mays

<400> 444

cgaagagcca actgcaacag atcgcatgac caatgtacag caaccacct ggtcagtgtg 60
cactggttgt ttgtataatc ctcaagtatc cagaattgaa gagtttgtgg ttaaaagaag 120
tcaaggggat ggctgatcgt atcattggaa tgcgtaattc acttaaggat aaatcttaat 180
agctagggtc acctttgtta tggatcata tatttaatta ttattgtatt gttctttttt 240
tgttttatatt attttttttt tttttttttt tttttttttt 279

<210> 445
<211> 355

<212> DNA
 <213> Zea mays

 <223> unsure at all n locations
 <400> 445

 gccagctgaa acgattggca cgtcccatgt nttcgaaccc ccctattcac ggtgccaaga 60
 nggttggnaa cnttgggtgg gatgcaacca ntgtttggtn aaatggaaac angagttggg 120
 tctaattngct tgancganc naagatngta ananaaaann ttaaaaacag gttntttttc 180
 aaaggncaaa aaccgcaaga actgggnttt tatttnnagg ggntattgna atgttttttt 240
 anacggnttt aaaaaaannc antgggnaac attgcggnntn anntggatnt tatttgacaa 300
 angnnngggg gatttgnaaa natggggntnt cctggggttaa cggggatatt ttigc 355

<210> 446
 <211> 442
 <212> DNA
 <213> Zea mays

 <400> 446

 cggacgcgtg ggatgagatg caagcagttg ctgtcaagag ccaactgcaa cagatcgcaa 60
 gaccaatgta cagcaaccca cctgttcatg gtgcaactgg tgtttctata atcctcagtg 120
 atccagaatt gaagagtttg tgggttaaaag aagtcaaggg tatggctgat cgtatcattg 180
 gaatgcggaa ggcaacttaag gaaaatcttg aaaagctagg ttcacctttg tcatgggatc 240
 atatcactaa tcagattgga atgttctgct acagtgggat gacacctgaa caagttgacc 300
 gtttaacaaa tgaataccac atttacatga cccgcaatgg gtggataagc atggctgggt 360
 ttacgacagg aaatgttggg tacctagcaa attcttttca tgaggttacc aaactcaatt 420
 tagttatggg cctaccttct tt 442

<210> 447
 <211> 471
 <212> DNA
 <213> Zea mays

 <223> unsure at all n locations
 <400> 447

 gctagcagcc gcctcctcgt caggcctttt ttncctcacc ctgcgcaaac ccgcctcctn 60
 nggtccgaac tccgtctgct tcctctgagc gtccgggagg acaaaacacg cggcgaggac 120

caggatggcg attgtgcggg aggaggcaag tggacacgtc catcagccca agggtgagcg 180
cgctgcggcc gtccaaaacc atggccatca ccgatnaggc catggcgctg cggcaggccg 240
gcggtgccggg tatcggtcta gccgcggggg agccagactt ncgacacgcn ccccgatgat 300
ngggangccc ggattgatgc aattaggaat ggttatacaa agatacactt ntaatgctgg 360
gaacttttgaa ctgangaang ggtatttnta ctaaaacttn angaggagaa cgggggnttc 420
taacttccaa atnaaggctt tngtaacaan ggaactaaaa antnnntan a 471

<210> 448
<211> 433
<212> DNA
<213> Zea mays

<400> 448

caaaagccca cagcttcttc tccctactcc tccagtcctc cgtcatccgt ttcggtcgct 60
gccgccgcca ccgcacaaga agctagctcc tgccgtgtacc gcccgcgtcat ggcgatgcta 120
tcccgcgcag cctcctccgc ggcccggcgc ccgctgctgc cgcgcgctag gcttctggcg 180
gtgagggcga tggcgctgct gctcttcggc cagctcgagc cggcgcccaa ggaccccatc 240
ctcggcgctca ccgaggcttt cctcgccgac ccctcgctccg acaaagtga cgtcggcgctc 300
ggcgccctacc gggacgacaa cggccagccc gtcgtgctca gctgcgtgcg cgaggccgag 360
cgccggatcg cgggcaacct caacatggag taccttccga tgggaggcag cgtcaagatg 420
attgaagagt cac 433

<210> 449
<211> 237
<212> DNA
<213> Zea mays

<400> 449

cggacacgtg ggtctgccgc cgccaccgca caagaagcta gctcctgcct gtaccacccc 60
ggcatggcga tgctatcccg cgcagcctcc tccgcggccc ggcgcccgct gctgccgccc 120
cctaggcttc tggcgggtgag ggcgatggcg tcgtcgtctt tgggccacgt cgagccggcg 180
cccaaggacc ccctcctcgg cgtcaccgag gctttcctcg ccgacccctc gtccgac 237

<210> 450
 <211> 371
 <212> DNA
 <213> Zea mays

<400> 450

ccattctttg atgttgcata tcaaggTTTT gccagtggaa gccttgatga agatgcattt 60
 tctgtcaggc tttttgttaa gcgTggcatg gaagtgtttg ttgcacaatc ttacagcaag 120
 aaccttggtc tatattctga aagggttggT gcgataaatg tcgtgtgctc agcaccagaa 180
 gttgcagata gggtaaagag ccagctgaaa cgattggcac gtcccatgta ctCGaacccc 240
 cctattcacg gtgccaagat agttgccaac gttgttggTg atccaatcat gtttggTgaa 300
 tggaacaag agatggagct aatggctgga cggatcaaga atgtaagaca gaagctctac 360
 gacagtttgt c 371

<210> 451
 <211> 433
 <212> DNA
 <213> Zea mays

<400> 451

acggccaggt gaaacgattg gcacgtacca tgtattcgat accccgctat tcacggTgcc 60
 aagatggTtg gcgaacgttg ttggTgatgc aaccatgttt ggtgaatgga aacaagagat 120
 ggagctaatt gctggactga tcaagaatgt aagacaaaag ctctacgaca gtttgtctgc 180
 caaggacaag agcggcaagg actggTcttt cattctgagg cagattggca tgttctccta 240
 caccggcttg aacaaagcgc agagtgacaa catgacggat aaatggcata ttacatgac 300
 caaggatggg cggatctcgt tagctgggct gtccctggct aagtgtgatt atcttgccga 360
 cgccatcatc gattccttcc ataatgtgaa ctatgctgaa gtactatagt tgagggTcaa 420
 gctattgatg ttt 433

<210> 452
 <211> 362
 <212> DNA
 <213> Zea mays

<400> 452

accacgcgt ccgggaaaca agagatggag ctaatggctg gacggatcaa gaatgtaaga 60

cagaagctct acgacagttt gtctgccaag gacaagagcg gcaaggactg gtctttcatt 120
ctgaggcaga ttggcatggt ctctacacc ggcttgaaca aagcgagag tgacaacatg 180
acggataaat ggcatattta catgaccaag gatgggcgga tctcgttagc tgggctgtcc 240
ctggctaagt gtgattatct tgccgacgcc atcatcgatt ccttcataa tgtgaactag 300
gctgaggtag gatagttgag ggtcaagcta ttgatgttta gttccgtgga cgctaggctg 360
gg 362

<210> 453
<211> 493
<212> DNA
<213> Zea mays

<223> unsure at all n locations
<400> 453

gtncgcagtt taggaacgtt agcctgtcag tacgcgtcga aattccaagg tcccaccaag 60
ccttcgtagg aaccaaaaaa tggaccaaat ggctggacgg ttaaaaaatg taagacagaa 120
cctctacaac agtttgtctg ccaaggacaa aaccggcaag gactggtctt tcattctgag 180
gcagattggc atgttctcct acaccggctt gaacaaagcg cagagtgaca acatgacgga 240
taaattggcat atttacatga ccaaggatgg gcggatctcg ttagctgggc tgtccctggc 300
taagtgtgat tatcttgccg acgccatcat cgattccttc cataatgtga actaagctga 360
ggtacgatag ttgaggggtca agctattgat gtttagttcc gtggacgcta ggctgggatt 420
tttgggtcct tccagctata cagctcttcc cgttgtgctc aatctggtgt aacttgata 480
aataaaattt tgt 493

<210> 454
<211> 336
<212> DNA
<213> Zea mays

<400> 454

cccgctccg atccgctgct tactcgccac ccggagatgg ccacgcgcgc cgccttctcc 60
gtctcctcgc cggcggcctc cgccgtcgcc gcgcgatcca aggtgttttg aggagttaag 120
caggcgagaa ctagaactgg ctgccgcac tgcatcacgc ggaagaactt tggcgtgtc 180

atgatggccc ttgcagtgga tgtttctcgt tttgaaggac tgccaatggc tcctccagac 240
ccaattcttg gggtttctga ggcttttaaa gcagagtaga gcgagctgac gctcaatctt 300
ggtgttggtg cctataggac agaggagctg cagcca 336

<210> 455
<211> 422
<212> DNA
<213> Zea mays

<400> 455

cgaaaagcta agcagagaga acaagcttac caaatcatca gtcattggtca ctgctggtgc 60
aatcaggct tttgtgaact tggctctcac tctttgtgat gctggtgatt ccgttgtcat 120
gtttgcaccg tattattttca atgcctacat gtcattccag atgacaggtg ttactgacat 180
attagttggt ggctgcgac ccaagacact tcattcctgat gttgattggt tggagaaggt 240
tctgaaagaa aatgagccta tccctaaact tgtcactggt gtgaatccgg ggaacccctg 300
tgagagcttt atttcaaggc ctatgcttga gagaatttca gatctgtgca aaaatgctgg 360
tgcattggctt gtggttgaca atacctatga gtactttatg tatgatggaa tggagcacta 420
ct 422

<210> 456
<211> 389
<212> DNA
<213> Zea mays

<223> unsure at all n locations
<400> 456

agacacctcc gccacctcca cctcgaatc gttccccacc atggcgctgc agggatcctc 60
cgtcttcgcc gcaactcgagc agggccccga ggacccccatc ctcgagtgga ccgttgcccta 120
caacaaggat cccagccccg tgaagggtcaa cctcggggtc ggcgcctacc ggaccgagga 180
aggggaagccc ctagtgtgta acgtgggtcag gcgcgcccag caaatgttga tcaataatcc 240
gtcacgtgtc aaggagtacc taccaatcac cgggtctggct gaattcaata agctgagcgc 300
taagcttacc tttggcgtg acagccctgc tattcaggag aatanggtt ctaccgtgca 360
gtgcctatcg ggtactggtt ctttaagag 389

<210> 457
 <211> 382
 <212> DNA
 <213> Zea mays

<223> unsure at all n locations
 <400> 457

gcagcagaca cctccgccac ctccaccctc gaatcggtcc ccaccatggc gtcgcaggga 60
 tcctccgtct tcgccgact cgagcaggcc cggaggacc ccatectcgg agtgaccgtt 120
 gcctacaaca aggatcccag ccccggtgaag gtcaacctcg gggtcggcgc ctaccggacc 180
 gaggaaggga agcccctagt gctgaacgtg gtcaggcgcg ccgagcaaatt gttgatcaat 240
 aatccgtcac gtgtcaagga gtacctacca atcaccggtc tggctgaatt caataagctg 300
 agcgctaagc ttatcttttg cgtgacagc cctgctattc aggagaatan ggttgctacc 360
 gtgcagtgcc tatcgggtac tg 382

<210> 458
 <211> 337
 <212> DNA
 <213> Zea mays
 <400> 458

ctcgaatcga tccccaccat ggcgtcgcag ggatcctccg tcttcgccgc actcgagcag 60
 gccccggagg accccatcct cggagtgcac gttgcctaca acaaggatcc cagccccgtg 120
 aaggtaacc tcggggtcgg cgctaccgg accgaggaag ggaagcccct agtgctgaac 180
 gtggtcaggc gcgccgagca aatgttgatc aataatccgt cacgtgtcaa ggagtaccta 240
 ccaatcaccg gtctggctga attcaataag ctgagcgcta agcttatctt tggcgctgac 300
 agccctgcta ttcaggagaa tagggttgct accgtgc 337

<210> 459
 <211> 429
 <212> DNA
 <213> Zea mays
 <400> 459

gtccgacgtc ccaccggccc ccgtctcgt tttccccgc cggaacaagc acgtcaagc 60
 gctgcgcaac ggattggccc tgctaacgtt cggccgggc aagggaagg cccaacgcc 120

caacgcaagg taagttagcc aattgggcaa ctggcggctt tctccccaag aaaaacaaca 180
agcaaaaaact tcggcaacct caaccctcga atcggtcccc accatggcgt cgcagggatc 240
ctccgtcttc gccgcactcg agcaggcccc ggaggacccc atcctcggag tgaccgttgc 300
ctacaacaag gatcccagcc ccgtgaaggt caacctcggg gtcggcgcct accggaccga 360
ggaagggaag cccctagtgc tgaacgtggt caggcgcgcc gagcaaagt tgatcaataa 420
tccgtcacg 429

<210> 460
<211> 411
<212> DNA
<213> Zea mays

<400> 460

acgcccacct ggagagctac tcgcgcgtgc tcgagagcct ggcgtaacgc gtcattgtccc 60
gcatcgagga cgtgctgagc gcggacgcgg cggcgacaga cctgacggcg agcgaggcgg 120
cgcggcgagc gctggagtcg acgtcggcgg agctgccgcg ggcgcggaag ctggacgcca 180
aggaggagct ggagaagctg aacgaggccc cggcgctgat gacgctgttc gacttcatgg 240
gctggcactt cgaccaggac gagctgatga agcgcaggga ggacggcaca ctggacgcgg 300
acggggaggg catgctcctc aagaaggcgc ctagcatggc cccaagaag ttctcctacg 360
tcgacagcct ctctccggc ggcatgagga gccctccgc gcgccactga t 411

<210> 461
<211> 417
<212> DNA
<213> Zea mays

<400> 461

ccacgcgtcc gcgggtacgc cctcctggag agctactcgc gcgtgctgga gagcctggcg 60
tacagcgtca tgtcccgcat cgaggacgtg ctgagcgcgg acgcggcggc acagaacctg 120
acggcgaccg aggcggcgcg gcgggtgctg gactcggcgg acctgctcgc gccgcggaag 180
ctggacgcca aggaggagct ggagaagctg aacgaggccc cggcgctgat gacgctcttc 240
gacttcatgg gctggcactt cgaccaggac gagctgatga agcgcaggga ggacggcacg 300
ctggacgcgg acggcgaggc catgctcctc aagaaggcgc ccagcgtggc gccaagaag 360

ttctcctacg tcgacagcct ctctctcggc ggcattgagga gccctctgc gcgccac 417

<210> 462
 <211> 411
 <212> DNA
 <213> Zea mays

<400> 462

aacaaagcaa cagcagagct attgcttggg gctgataacc ctgttattaa tcaaggactg 60
 gttgctgcac ttcagtctct ctggggcact ggatcactgc gtctcgctgc agcattcata 120
 caaagatact ttctgaagc taaagtgtg atatcgtgc ctacctgggg taaccacaag 180
 aatatcttca atgatgctag ggtaccttgg tcagagtacc ggtattatga cccaagact 240
 gttgggttgg attttgaggg aatgatagct gacattgaag ctgctcctga aggttctttt 300
 gttctgtac atggttgtgc tcacaacca actggaatag acccaactcc tgaacagtgg 360
 gagaaaattg cagatgtcat tcaagagaaa aagcatatgc cattctttga t 411

<210> 463
 <211> 441
 <212> DNA
 <213> Zea mays

<223> unsure at all n locations
 <400> 463

tgagggtgga gaggatattg aannttccca gtctcncagt cgcnatatct ctggaattac 60
 cttatcgacc caggcgtcct aacaaagcaa catcagagct attgcttggg tctgattacc 120
 ctgttattaa tcaaggactg tgtgctgcac tacagtctct ctggggcact ggatcactgc 180
 gtctcgctgc agcattcata caaagatact ttctgaagc taaagtgtg atatcgtctc 240
 ctacctgggg taaccacaag aatatcttca atgatgctag ggtaccttgg tcagagtacc 300
 ggtattatga cccaagact gttgggttgg attttgaggg aatgatagct gacattgagg 360
 ctgctcctga acgttctttt gttcttctac atggttgggt ctcacaacc aactggaata 420
 gaccacaactc cttaacattt t 441

<210> 464
 <211> 318
 <212> DNA
 <213> Zea mays

<400> 464

gttgggtgcct ataggacaga agagctgcag ccatacgtgc tcaatgtagt caagaaggct 60
gaaaatctta tgttggagaa aggagaaaac aaagagtatc ttcccattga aggttttagcc 120
gcgtttaaca aagcaacagc agagctattg cttggagctg ataaccctgt tattaatcaa 180
ggactgggtg ctacaacttca gtctctctcg ggcactggat cactgctctc cgctgcagca 240
ttcatacaaa gatactttcc tgaaactaaa gtgctgatat cgtcgcctac ctggggtaac 300
cacaagaata tcttcaat 318

<210> 465

<211> 427

<212> DNA

<213> Zea mays

<400> 465

cggacgcgtg ggcaagaatg ctccagatgg ttcattottt ttgcttcatg catgtgctca 60
taatcccacc ggtgtagatc ctacggagga acaatggaga gaaatatccc atcagttcaa 120
ggtgaaaaaa cattttccat tttttgacat ggcataccaa gggtttgcca gtggtgatcc 180
agagagagat gccaaggcaa tccgaatttt ccttgaagat ggacacccaa ttggatgtgc 240
tcagtcatac gcaaagaaca tgggacttta tggacaaaga gcaggatgcc tgagtatttt 300
gtgtgaggat gagatgcaag cagttgctgt caagagccaa ctgcaacaga tcgcaagacc 360
aatgtacagc aaccacactg ttcatgggtgc actggttggt tctataatcc tcagtgatcc 420
agaattg 427

<210> 466

<211> 434

<212> DNA

<213> Zea mays

<400> 466

ggcaaactga cttatatcag caagacgttc agaagtatgg aaacattgag tacatgagat 60
gcgggtccaga aaatggattt tttcctgatc tgtcaactgt ccctaggaca gatattattt 120
tcttttgttc acccaacaat cctactgggtg ctgctgcac tcgggaccaa ctaaccaa 180
tagtaaaatt tgcaaaggac aacagggtcca tcatagtcta tgattctgct tatgcaatgt 240

acatatcaga tgacagccca aagtctatct ttgaaattcc tggagcaaag gaggttgcta 300
 ttgagacagc ctcattctcg aaatacgtcg ggttcacagg tgtccgtcta ggttggactg 360
 ttgtcccaaa ggagctcctt ttctcggatg gacatccagt tgctaaagat ttcaatcgca 420
 tagtttgcac ttgc 434

<210> 467
 <211> 497
 <212> DNA
 <213> Zea mays
 <223> unsure at all n locations
 <400> 467

ggggggntaa agggggantt tattggaacc ccaattcccg ggtaccggta ttatgatcct 60
 gcaacatgca gccttcactt cgaaggactc ctggaagacc tcggttctgc tccttnaggt 120
 tcaatngtac tgctgcatgc ctgtgtcac aacctactg gagtagatcc taccatcgaa 180
 cagtgggaac agattaggca gctgatgaga tcaaaatcac tgcttcggtt ctttgacagt 240
 gcctatcaag gctttgcaag tggaagtctt gacaaagatg ctcaagtcat gcgtatgttt 300
 gttgctgatg gtggtgaact tctcatggct cagagctacg ctaagaacat gggattgtat 360
 ggagagcgtg ttggcgcttt gagcattgna tgtaaaagtg ccgatgtagc tgttagggtt 420
 gaaagtcaac tcaaacttgn catcaggcct atgtattcaa acccttctct tcatggngcc 480
 tctatcgntg ctacat 497

<210> 468
 <211> 386
 <212> DNA
 <213> Zea mays
 <400> 468

ttatcatggc tcagagctac gctaagaaca tgggattgta tggagagcgt gttggcgctt 60
 tgagcattgt atgtaaaagt gccgatgtag ctgttagggt tgaaagtcaa ctcaaacttg 120
 tcatcaggcc tatgtattca aacctcctc ttcatggtgc ctctatcgtt gctaccatac 180
 tcagggacag cgagatgttc aacgaatgga ctctggaact gaaggccatg gctgatagga 240
 tcattaacat gaggcaacaa ctatttaatg cgctgaaatc cagaggaacc cctggtgatt 300

ggagccatat cattaagcaa attgggatgt ttactttcac tggggcctga atagcgaaac 360
aaagtcgccc cattcatgag gcagga 386

<210> 469
<211> 405
<212> DNA
<213> Zea mays

<223> unsure at all n locations
<400> 469

actccaata gtgagtcgta ttacagagct acgctaagaa catgggattg tatggagagc 60
gtgttggcgc tttgagcatt gtatgtaaaa gtgccgatgt agctgttagg gttgaaagtc 120
aactcaaact tgtcatcagg cctatgtatt caaacccctcc tcttcatggg gcctctatcg 180
ttgctaccat actcagggac agcgagatgt tcaacgaatg gactctggaa ctgaaggcca 240
tggtgatag gatcattaac atgangcaac aactatttaa tgcgctgaaa tccangagga 300
accctgggtg attggagcca tatcattaaa gcaaattggg atgtttacnt tccctggggg 360
cngaaataa cgaagcnngg tcggccnntt cangagggna gggag 405

<210> 470
<211> 396
<212> DNA
<213> Zea mays

<400> 470

cccacgcgtc cgcccacgcg tccggcgtgt tggcgcttcg agcattgtat gtaaaagtgg 60
cgatgtagct gggagggttg aaagtcaact caaacttgct atcaggccta tgtattcaaa 120
ccctcctata catggtgcct ctatcgggtgc taccatactc agggacagcc agatgttcaa 180
cgaatggact ctggaactga aagccattgc tgataagatc attcacatga ggcattcaact 240
atttaatgcc cctaaatcca aatgaacccc tggagattgg agccatatca ttgagcacat 300
tcggatgtac actgtgactg agctgaataa cgaacaagtc gcattcatga ggcaggaata 360
cctcatttac atgacatctg atgatatgaa catcat 396

<210> 471
<211> 416
<212> DNA
<213> Zea mays

<400> 471

agttgctacc atactcaggg acagcgagat gttcaacgaa tggactctgg aactgaaggc 60
catgggttgaa aggttaatat acataaggca acaccaatta atgccccgga atccaaaaga 120
aaccctggtg aatggagcca tatcaataag caaattggga tgtttacttt cactgggctg 180
aatagcgaac aagtcgcatt cacgaggcac gaataccaca tttatatgac atctgatggg 240
aagatcagca tggccggttt gagcatgagg actgtgcccc atcttgacac tgccatacac 300
gctgcagtta ctcaactgaa atgaggatag tatcgagct ttcgtgaata aaacctgaat 360
catccacaac aatgttctaa gtactcatcc actgggtattt actggttgac ctactg 416

<210> 472

<211> 404

<212> DNA

<213> Zea mays

<223> unsure at all n locations

<400> 472

ccctatagtg agtcgtatta aagagctacg ctaagaacat gggattgtat ggagagcgtg 60
ttggcgcttt gagcattgta ngtaanagtg ccgatgtagc ngtnagggnt gaaagtcanc 120
tcaancttgt catcaggcnn atgtattcaa accctcctct tcatggtgcc tctancgttg 180
ctaccatnct cagggacagc gagatgttca nogaatggac tctggaactg aaggccatgg 240
ctgataggat cattaacang aggcaacaac tatttaatgc gctgaaatcc agaggaaccc 300
ctggtgantg gagccatntc ngttaagnca aattgggatg tntactttca nngggggcct 360
naagtaagcg aaacagnntn cgncccttcc cggngggcgg ggag 404

<210> 473

<211> 294

<212> DNA

<213> Zea mays

<400> 473

atacacgctg cagttactca actgaaatga ggatagtatc gcagctttcg tgaataaaac 60
ctgaatcacc cacaagaatg ttctaagtac tcagccagtg gtatttactg gttgacctac 120
tgtagtttgc gtcggaatag atatgttttt ttactcttcg tggggcagtt ttgtactggt 180

ggattcataa ggactctgat tatggtgcgt tcggaactta taataataag cacatgaaat 240
 ttgcttcaa aaaaaaacta tatcacctc aatactacaa caacagtcag ccac 294

<210> 474
 <211> 259
 <212> DNA
 <213> Zea mays
 <400> 474

actgaaatga ggatagtatc gcagctttcg tgattaaaac ctgaatcacc cacagcgggtg 60
 ttctaagtac tcagccagtg gtatttaactg gttgacctac tgtagtttgc gtcggaatag 120
 atttgttttt ttactcttcg tggggcagtt ttgtactggt ggattcataa ggactctgat 180
 tatggtgcgt tcggaactta taataataag cacatgaaat ttgcttcaa aaaaatacta 240
 ccattcaaac agataaaaa 259

<210> 475
 <211> 262
 <212> DNA
 <213> Glycine max
 <223> unsure at all n locations
 <400> 475

ccaaagaggt tgccatcgag acttcatcat ttagcaagta tgctgggttc actggagtcc 60
 gattgggttg gactgtggtt ccaaagcagt tgctgttttc tgatggattt cctgttgcca 120
 aggacttcaa ccgtattgta tgcacttggt tcaatggtgc atcaaatatt tcccaggcag 180
 gtggtctggc ttgcctttca ccagacggtc ttaaggctat gcgagatgtt attggattct 240
 acaaaganaa taccgacatt at 262

<210> 476
 <211> 262
 <212> DNA
 <213> Glycine max
 <400> 476

ctcgagccgc tgcataccc acttcccctt caagagcaca cgcccagatc agcgттаааа 60
 acgtottaca actgcgaaac aaaaccaatc tgaaatgtcc gaccaacaag agatttacgc 120
 tgcgttcccc aacgtccctc aggctcctcc tgattccatc ttccaattga ccgctcgтта 180

gcagatgcc a tacacgctgc agttactcaa ctgaaatgag gatagtatcg cagcttttcgt 240
gaataaaaacc tgaatcaccc acaacaatgt tctaagtact cagcca 286

<210> 480
<211> 256
<212> DNA
<213> Glycine max

<400> 480

tcttccaggt aaaaaatcat ttcccattct ttgacatggc ttatcaagga ttttcaagtg 60
gggatcttga caaggatgca atagcacttc gaatttttct tgaagatggg catttgattg 120
gttgtgtctca atctttttgca aagaacatgg gattatcaga acataaaagct ggttgtctta 180
ggtaagaata gtcctatatc ctagtgagta gagattcaga ggcagagcat attctatgac 240
acgtataata gaagtt 256

<210> 481
<211> 232
<212> DNA
<213> Glycine max

<400> 481

ctttttatga tgttctgttc tgcattatit tcaggtcacg caacaaggaa tatattccgt 60
tcgttgggct tgctgatttt aataaattga gtgctaagct tatttttcgg gctgacagcc 120
ctgctattca agacaacagg gttaccactg ttcaatgctt gtctggaact ggttctttta 180
gagttggggg tgaatttttg gctaaacact atcaccaacg gactatatac tt 232

<210> 482
<211> 209
<212> DNA
<213> Glycine max

<223> unsure at all n locations
<400> 482

gccgaaaggn ttggngcaat caatgtgggt tcatcatcgc ccgaatctgc agcaagggta 60
nanagtcagt tgtaaggatt gcccgaccan gtactcta at ctncagtaca cgnggtagat 120
agtnngcgtgt gttggaanca gtccttatga tgaagnga at gcatgtgggt gagntaagnt 180

tagcacgtat agtattattc aagacanag

209

<210> 483
<211> 236
<212> DNA
<213> Glycine max

<400> 483

ttccagagcc ccttctaaag aggatttcag atctctgcaa gaatgctggc tcttggttg 60

ttgttgataa tacatacgag tattttatgt atgatggcct gaaacactct tgtgttgagg 120

gaaatcatat tgtaaatgtt ttctcattct caaaagcata tggaatgatg ggatggcggg 180

ttggatatat agcgtacccc tctgaagtaa aagacttcgc tgaacaactt ctcaaa 236

<210> 484
<211> 247
<212> DNA
<213> Glycine max

<400> 484

ggaacttttg tgtgctgttc tacttctggt acatctcgtg aatcgtttgc aacttcttca 60

ccgttttctg tatgcagatg gcttcttcgt ttctatccgc agcttcgcac gctgtctcac 120

cctcttggtc tctgtccacc acgcacaacg ggaagcacat gcttggaggc aacactttga 180

gatttcacaa aggacccaat tccttctcta gttcaaggtc tagaggtcgg atctctatgg 240

ctggttgc 247

<210> 485
<211> 153
<212> DNA
<213> Glycine max

<400> 485

ccacagagga cccaattcct tctctagttc aaggctctacc ggctggatct ctatggctgt 60

tgcagttaac gtttctcggg ttgaaggcat acctctggcg cctcctgac caattctagg 120

agtttctgag gcatttaagg tggacaatag tga 153

<210> 486
<211> 271
<212> DNA

<213> Glycine max
 <400> 486
 agagcagttg aaaaggattg cccgaccaat gtactctaata ccaccggtac acggggctag 60
 gatagttgcc gatgttggtg gaaacccagt tctctttaat gaatggaaag cagagatgga 120
 aatgatggct ggaaggataa agaatgttag acagcagcta tatgatagta ttacttcgaa 180
 agacaaaagt ggaaaggatt ggtcattcgt acttaagcag ataggcatgt tctcattcac 240
 tggcttgaac aagaaccaga gtgacaacat g 271

<210> 487
 <211> 247
 <212> DNA
 <213> Glycine max

<400> 487
 aacggagcca aacagagtat tgctcaggca gtgottgcag tttcctcccc tggagatgag 60
 gttattattc cagctccatt ctgggttagt taccagaaa tggcaagggt ggctgatgca 120
 acacctgtga ttcttccaac cttaatatct gataatttcc ttttggatcc caaactcctc 180
 gaatccaaaa ttactgaaag atcaagactg cttattcttt gttctccatc taaccaacg 240
 ggatctg 247

<210> 488
 <211> 261
 <212> DNA
 <213> Glycine max

<400> 488
 cggagcaaac agagtattgc tcaggcagtg cttgcagttt cctcccctgg agatgaggtt 60
 attattccag ctccattctg ggtagttac ccagaaatgg caagggttggc tgatgcaaca 120
 cctgtgatcc ttccaacctt aatatctgat aatttcttt tggatcccaa actcctcgaa 180
 tccaaaatta ctgaaagatc aagactgctt attctttgag ctccatctaa cccaacggga 240
 tctgtctacc ccaaagaatt a 261

<210> 489
 <211> 273
 <212> DNA

<213> Glycine max
 <400> 489

gggattagtt atactcctga ccaagttgtg gttagtatcg gagccaaaca gagcattgct 60
 caggcagtgc ttgcagtttg ctccccgga gatgagggtta ttattccagc tccattctgg 120
 gttagttacc cagaaatggc aaggttggct gatgcgacac ctgtgattct tccaacctta 180
 atatctgata atttcctttt ggatcccaaa ctcttgaat ccaaaattac tgaaagatcg 240
 agactgctca ttctttgttc accatctaac' cca 273

<210> 490
 <211> 273
 <212> DNA
 <213> Glycine max

<223> unsure at all n locations
 <400> 490

cggggctagg atagtngccg atgttggttg aaaccagtt ctctttaatg aatggaaagc 60
 agagatggaa atgatggctg gaaggataaa gaatgttaga cagcagctat atgatagtat 120
 tacttcaaaa gacaaaagtg gaaaggattg gtcattcata cttaagcaga taggcatgtt 180
 ctcatctact ggcttgaaca agaaccagag tgacaacatg acaaacaagt ggcacgtata 240
 catgacaaag gatggaagga tttccctggc agg 273

<210> 491
 <211> 258
 <212> DNA
 <213> Glycine max

<400> 491

aaagaatggt agacagcagc tatatgatag tattacttca aaagacaaaa gtggaaagga 60
 ttggtcattc atacttaagc agataggcat gttctcattc acgggcttga acacgaacca 120
 gaggtagaac atgacaaaca agtggcacgt atacatgaca aaggatggaa ggatttcctt 180
 ggcaggattg tcattggcta aatgtgaata cottgcagat gctattattg actcatatca 240
 taatgtcagc tgaaactc 258

<210> 492
 <211> 249

<212> DNA
 <213> Glycine max
 <400> 492

tgccgatgtt gttggaaacc cagttctctt taatgaatgg aaagcagaga tggaaatgat 60
 ggctggaagg ataaagaatg ttagacagca gctatatgat agtattactt caaaagacaa 120
 aagtggaaag gattggtcat tcatacttaa gcagataggc atgttctcat tcaactggctt 180
 gaacaagaac cagagtgaca acacgacaaa caagtggcac gtatacatga caaaggatgg 240
 aaggatttc 249

<210> 493
 <211> 268
 <212> DNA
 <213> Glycine max
 <400> 493

gttcgcactc tgtctttccc ctgtttccgc gtcactgagt catcgcgatt cgcaactcgc 60
 tcaccggcca attcctccgc cgcagctccg tcgccggagc aaggctcatg tcttcttcgt 120
 cctcatgggt cccgagcatc gagcccgtc ccaaggatcc tatectcgga gtcactgaag 180
 ctttctctgc cgatcagagt ccaaacaaag tcaacgtcgg agtgggtgcg tatecgcatg 240
 accacggaaa acctgtgggt ttggaatg 268

<210> 494
 <211> 268
 <212> DNA
 <213> Glycine max
 <400> 494

ctctctccct ctctgttcgc actctgtctt tcccctgttt ccgcgtcact gagtcatggc 60
 gattcgcaac tcgtcaccg gccaatcct ccgccgcagc tccgtcgccg gagcaaggct 120
 catgtcttct tcgtcctcat ggttccggag catcgagccc gctcccaagg atcctatcct 180
 cggagtcaact gaagctttcc tcgccgatca gagtccaaac aaagtcaacg tcggagtggg 240
 tgcgtatcgc gatgaccacg gcaaacct 268

<210> 495
 <211> 241

<212> DNA
 <213> Glycine max
 <400> 495
 cctctctgtt cgcactctgt ctttcccttg tttccgcgtc actgagtcac tgcgattcgc 60
 aactcgctca ccggccaatt cctccgccgc agctccgtcg ccggagcaag gctcatgtct 120
 tcttcgtcct catggttccg gagcatcgag cccgttccca aggatcctat cctcggagtc 180
 actgaagctt tcctcgccga tcagagtcca aacaaagtca acgtcggagt ggggtgcgtat 240
 c 241

<210> 496
 <211> 170
 <212> DNA
 <213> Glycine max
 <400> 496
 ctctctccct ctctgttcgc actctgtctt tcccctgttt ccgcgtcaact gagtcacgc 60
 gattcgcaac tcgtcaccg gccaatcct ccgccgcagc tccgtcgcgc gagcaaggct 120
 catgtctctt tcgtcctcat ggttcgggag catcgagccc gctcccaagg 170

<210> 497
 <211> 284
 <212> DNA
 <213> Glycine max
 <223> unsure at all n locations
 <400> 497
 ggagatgggt tcgtccgtga agctttcagg agggccttgg aaactgagat gcccgttatg 60
 gttcagatgc aggaattgca acgaggagct aagaatgcct tgtctttggc ccaggggggtg 120
 gtttactggc agcctcccaa gcaagcgttg gaaaaagtga aagaacttgt atctgagcct 180
 ttaattagtc gttatggtaa cgatgaaggt attcctgaac tcagagcagc attagtcaaa 240
 aagttgcgng atgaaaataa ttgcacaaa tcttcagtat gggt 284

<210> 498
 <211> 276
 <212> DNA
 <213> Glycine max

<400> 498

caacatttta ctgggtatat aagtggagag tgtaactgaa attatgtgga ggtgcatcaa 60

tggaagaatt gccagaagat ttttatccac ttcttctgcc agtgcccgtg gttggtggga 120

ccatgtaagg ccagcaccga aggaccccat tgttcgtgtg aacgaggcat ttctagctga 180

cccttttccc cataagatca atcttggaat aggtacttat aagggatgat atggcaaagc 240

tttcattcct caaagcggtc gtgaggcaga aacaaa 276

<210> 499

<211> 290

<212> DNA

<213> Glycine max

<223> unsure at all n locations

<400> 499

attaagcaac attttactgn tgtatataag tggagagtgt aactgaaatt atgtggaggt 60

gcatcaatgg aagaattgcc agaagatttt tatccacttc ttctgccagt gcccggtggtt 120

ggtgggacca tgtaaggcca gcaccgaagg accccattgt tcgtgtgaac gaggcatttc 180

tagctgaccc ttttcccat aagagcaatc ttggaatagg tacttataag ggtgatgatg 240

gcaaagcttt cattcctcaa agcggtcgtg aggcagaaac aaagattcag 290

<210> 500

<211> 273

<212> DNA

<213> Glycine max

<400> 500

caacatttta ctgggtatat aagtggagag tgtaactgaa attatgtgga ggtgcatcaa 60

tggaagaatt gccagaagat ttttatccac ttcttctgcc agtgcccgtg gttggtggga 120

ccatgtaagg ccagcaccga aggaccccat tgttcgtgtg aacgaggcat ttctagctga 180

cccttttccc cataagatca atcttggaat aggtacttat aagggatgat atggcaaagc 240

tttcattcct caaagcggtc gtgaggcaga aac 273

<210> 501

<211> 263

<212> DNA

<213> Glycine max

<400> 501

aagcaacatt ttactgggta tataagtgga gagtgttaact gaaattatgt ggaggtgcat 60

caatggaaga attgccagaa gattttttatc cactttcttct gccagtgcc gtggttggtg 120

ggaccatgta aggccagcac cgaaggaccc cattgttcgt gtgaacgagg catttctagc 180

tgaccctttt ccccataaga tcaatcttgg aataggtact tataaggggtg atgatggcaa 240

agcttttcatt cctcaaagcg ttc 263

<210> 502

<211> 246

<212> DNA

<213> Glycine max

<400> 502

gaattaagca acatttttact gggatatataa gtggagagtg taactgaaat tatgtggagg 60

tgcataaatg gaagaattgc cagaagattt ttatccactt cttctgccag tgcccgtggt 120

tggtgggacc atgtaaggcc agcaccgaag gaccccatg ttcgtgtgaa cgaggcattt 180

ctagctgacc cttttcccca taagatcaat cttggaatag gtacttataa gggatgatgat 240

ggcaaa 246

<210> 503

<211> 261

<212> DNA

<213> Glycine max

<223> unsure at all n locations

<400> 503

taacatttta ctgggtatat aagtggagag tgtaactgaa attatgtgga tgtgcatcaa 60

tggaagaatt gccagaagat ttttatccac ttcttctgcc agtgcccggtg gttggtggga 120

ccatgtaagg ccagcaccga aggaccccat tgttcgtgtg aacgaggcat ttctagctga 180

cccttttccc cataagatca atcttggnaa aggtacttat aagggtgatg atggcaaagc 240

tttcatttct caaagcgttc g 261

<210> 504

<211> 236

<212> DNA

<213> Glycine max

<400> 504

aagcaacatt ttactgggta tataagtgga gagtgtgaacc gaaattatgt ggaggtgcat 60
caatggaaga attgccagaa gatttttatc cactttcttct gccagtgtccc gtggttggtg 120
ggaccatgta aggccagcac cgaaggaccc cattgttcgt gtgaacgagg catttctagc 180
tgaccctttt ccccataaga tcaatcttgg aataggtact tataaggggtg atgatg 236

<210> 505

<211> 380

<212> DNA

<213> Glycine max

<400> 505

ctggttcttt aagagttggg ggtgaatttt tggctaaaca ctatcaccaa cggactatat 60
acttgccaac accaacttgg ggcaatcacc cgaagttttc aacttagcag gcttgtctgt 120
caaaacatac cgctactatg ctccagcaac acgaggactt gactttcaag gacttctgga 180
agaccttggg tctgctccat ctggatctat tgttttgcta catgcatgcg cacataaccc 240
cactggtgtg gatccaaccc ttgagcaatg ggagcagatt aggcagctaa taagatcaaa 300
agctttgtta cttttctttg acagtgttta tcagggtttt gctagtggaa gtctagatgc 360
agatgcccaa cctgttcggt 380

<210> 506

<211> 329

<212> DNA

<213> Glycine max

<223> unsure at all n locations

<400> 506

goggactata tacttgccaa caccaacttg gggcaatcac ccgaagtttt caacttagca 60
ggcttgtctg tcaaaacata ccgtactatg ctccagcaac acgaggactt gactttcaag 120
gacttctgga agaccttggg tctgctccat ctggatctat tgttttgcta catgcatgcg 180
cacataaccc cactggtgtg gatccaaccc ttgagcaatg ggagcagatt aggcagctaa 240
taagatcaaa agctttgtta ctttctttga cagtgtttat cagggtttgc tatggnatct 300
agattgcaga tgccaactgt cgttggtgt 329

<210> 507
 <211> 261
 <212> DNA
 <213> Glycine max

 <223> unsure at all n locations
 <400> 507

attgttttgc tacatgcatg cgcacataac nacactgggtg tggatccaac ccttgagcaa 60
 tgggagcaga ttaggcagct aataagatca aaagctttgt tacctttctt tgacagtgtc 120
 tatcaggggtt ttgctagtgg aagtctagat gcagatgccc aacctgttcg tttgtttgtt 180
 gctgatggag gcgaattgct ggtagcacia agctatgcaa agaactctggg tctttatggg 240
 gaacgtgttg gcgccttaag c 261

<210> 508
 <211> 264
 <212> DNA
 <213> Glycine max

 <400> 508

ttcaatgctt gtctggaact ggttctttta gagttggggg tgaatttttg gctaaacact 60
 atcaccaacg gactatatac ttgccaacac caacttgggg caatcacccg aaggttttca 120
 acttagcagg cttgtctgtc aaacataacc gctactatgc tccagcaaca cgaggacttg 180
 actttcaagg acttctggaa gaccttggtt ctgctccatc tggatctatt gttttgctac 240
 atgcatgcgc acataacccc actg 264

<210> 509
 <211> 264
 <212> DNA
 <213> Glycine max

 <223> unsure at all n locations
 <400> 509

gggaagacct tggttctgct ccatctggat ctattgtttt gctacatgca tgcgcacata 60
 accccactgg tgtggatcca acccttgagc aatgggagca gattaggcag ctaatanca 120
 tcaaaagctt tgttaccttt ctttgacagt gcttatcagg gttttgctag tggaagtcta 180
 gatgcagatg cccaacctgt tcgtttgttt gttgctgatg gaggcgaatt gctggttagca 240

caaagctatg caaagaatct ggg

264

<210> 510

<211> 287

<212> DNA

<213> Glycine max

<223> unsure at all n locations

<400> 510

gcggactata tacttgccaa caccaacttg gggcaatcac cccgagtttt caacttagca 60

ggcttgtctg tacaaaacat accgctacta tgctccagca acacgaggac ttgactttca 120

aggacttctg gaagaccttg gttctgctcc atctggatct atgttttgct acatgcatgc 180

gcacataacc ccactggtgt ggatccaacc cttgagcaat gggagcagat tangcagcta 240

ataagatcaa aagctttgtt actttctttg acagngetta tcagggg 287

<210> 511

<211> 117

<212> DNA

<213> Glycine max

<400> 511

caggtattgc tacatgcatg cgcacataac cccactggtg tggatccaac ccttgagcaa 60

tgggagcaga ttaggctgct aatatgatca aaagctttgt tatcttacta cgacagt 117

<210> 512

<211> 273

<212> DNA

<213> Glycine max

<400> 512

aacaatccta ctggtgctgc ggcaacaagg gaacaactga cccaactcgt tcagtttgct 60

aaggacaatg gttctatagt aatccatgat tcagcttatg caatgtatat ttctgggtgac 120

aaccctcgtc ctatTTTTga aatcctggag ccaaagaggt tgccatcgag acttcatcat 180

ttagcaagta tgctgggttc actggagtcc gattgggttg gactgtgggt ccaaagcagt 240

tgctgttttc tgatggattt cctgttgcca agg 273

<210> 513

<211> 237
 <212> DNA
 <213> Glycine max

 <400> 513

 aacaatccta ctggtgctgc ggcaacaagg gaacaactga cccactcgt tcagtttgc 60
 acggacactg gttctatagt aatccatgat tcagcttatg caatgtatat ttctggtgac 120
 aaccctcgct ctatTTTTga aattcctgga gccacagagg ttgccatcga gacttcatca 180
 tttagcaagt atgctgggtt cactggagtc cgattgggtt ggactgtggt tccaaag 237

<210> 514
 <211> 276
 <212> DNA
 <213> Glycine max

 <400> 514

 ggggaacgtg ttggcgcctt aagcattgtc tgcaagtcag ctgatgttgc aagcagggtt 60
 gagagccagc tgaagctagt gattaggccc atgtactcaa gtcctcccat tcatggtgca 120
 tccattgtgg ctgccattct caaggaccgg aatttgttca atgactggac tattgagttg 180
 aaggcaatgg ctgatccatc atcagtatgc gccagaact tttcgatgct ttatgttcca 240
 gaggcacacc tggcgattgg agtcacatta tcaaac 276

<210> 515
 <211> 271
 <212> DNA
 <213> Glycine max

 <400> 515

 gcttatcagg gttttgctag tggaagtcta gatgcagatg cccaacctgt tcgtttgttt 60
 gttgctgatg gaggcgaatt gctggttagca caaagctatg caaagaatct gggctctttat 120
 ggggaacgtg ttggcgcctt aagcattgtc tgcaagtcag ctgatgttgc aagcagggtt 180
 gagagccagc tgaagctagt gattaggccc atgtactcaa gtcctcccat tcatggtgca 240
 tccattgtgg ctgccattct caaggaccgg a 271

<210> 516
 <211> 283
 <212> DNA

<213> Glycine max

<400> 516

tgcttatcag ggttttgcta gcggaagtct agatgcagat gccagcctg ttcgtttgtt 60
tggtgctgat ggggggtgaat tgctggtggc acaaagctat gcaaagaatc tgggtcttta 120
tggggaacgt gttggcgcct taagcattgt ctgaagtcag ctgatgttgc aagcagggtc 180
gagagccagc tgaaactagt gattaggccc atgtactcaa gtctctctat tcatggtgca 240
tccattgtgg ctgccattct caaggaccgg gatttgttca atg 283

<210> 517

<211> 227

<212> DNA

<213> Glycine max

<223> unsure at all n locations

<400> 517

aaagaatctg ggtcttttatg gggaacngt tggcgcotta agccttgtct gnccgtcagc 60
tgatgttgca agcaggggttg agagccagct gaagctagtg attaggccca tgtactcaag 120
tcctcccatt catggtgcat ccattgtggc tgccattctc aaggaccgga atttgttcaa 180
tgactggact attgagttga aggcaatggc tgatcgcac atcagtt 227

<210> 518

<211> 259

<212> DNA

<213> Glycine max

<223> unsure at all n locations

<400> 518

aagctttgnt acctttcttt gacagtgcnn atcagggntn tgctagnnga agtctagatt 60
gengatggcc caacctgttc gtttgtntgt tngtgatgna ggccaattgc tggtagcaca 120
aagctatgcn aagaatctgg gtcttnatgg ggaacgtgtt ggcgccctaa gcanngtctg 180
caagtcancct gatgttgcaa gcaggggtga gagccagctg aagctagtga taggcccctg 240
tactcaagtc ctcccattt 259

<210> 519

<211> 280

<212> DNA

<213> Glycine max

<400> 519

aacagattgg aatgtttact ttcactggat tgaatgcgga acaagtttcc ttcattgacta 60
aagagttcca tatatacatg acatctgatg ggaggattag catggctggg ctgagttcca 120
aaactgtccc acttctggcg gatgcgatac atgcagctgt aaccgagtt gtctaaaaca 180
tgttgacaac agttttcaac atgtcccta gtccotatag gagaacttcc attatttttg 240
tttaataatt gtcaacatca acaatgaaac cttttatttg 280

<210> 520

<211> 250

<212> DNA

<213> Glycine max

<400> 520

acattatcaa acagattgga atgtttactt tcactggatt gaatgcggaa caagtttccct 60
tcattgactaa agagttccat atatacatga catctgatgg gaggattagc atggctgggc 120
tgagttccaa aactgtccca cttctggcgg atgcgataca tgcagctgta acccgagttg 180
tctaaaacat gttgacaaca gttttcaaca tgctccctag tccotatagg agaacttcca 240
ttatttttgt 250

<210> 521

<211> 285

<212> DNA

<213> Glycine max

<400> 521

tacggctgcg aggacgacag aaggggataa tacatacgag tatttttatgt atgatggcct 60
gaaacactct tgtgttgagg gaaatcatat tgtaaatgtt tcctcattct caaaagcatt 120
tggaatagatg ggatggcggg ttggatatat agcatatccc tctgaagtaa aagactttgc 180
tgaacatctt ctcaaagttc aagacaacat tcccatctgt gcttcaatat tatcacagta 240
tcttgccctg tattcattgg aagtggggcc tcaatggggt gtaga 285

<210> 522

<211> 249

<212> DNA

<213> Glycine max

<400> 522

gggaaatcat attgttaatg tttttotcatt ctcaaaagca tttggaatga tgggatggcg 60
ggttggatat atagcatatc cctctgaagt aaaagacttt gctgaacaac ttctcaaagt 120
tcaagacaac attcccatct gtgcttcaat attatcacag tatcttgccc tgtattcatt 180
ggaagtgggg cctcaatggg ttgtagatca ggtaaaaact cttgaaaaga acagagaaat 240
tgtttttaga 249

<210> 523

<211> 264

<212> DNA

<213> Glycine max

<400> 523

gttgcgatgat gaaaataatt tgcacaaatc ttcagtaatg gttacatcag gtgccaatca 60
ggcattttgtg aatctagttc ttactctctg tgatccgggt gattctgtgg ttatgtttgc 120
tccttactac ttcaatgcgt acatgtcctt ccagatgact ggcatocca atattctagt 180
tggtcctggg agctcagaca cactccatcc tgatgcaggg gggtcacata ttgggttaa 240
gttggaatgga ttgggtctgt atac 264

<210> 524

<211> 296

<212> DNA

<213> Glycine max

<400> 524

cctggattta caacagtaac aagctttgga gccggtttat tttctgataa tattctttcc 60
aaccaatctg catcaggatg gagtgtgtct gagctaccag gaccaactag aatattggta 120
atgccagtca tctggaagga catgtacgca ttgaagtagt aaggagcaaa cataaccaca 180
gaatcaccgg gatcacagag agtaagaact agattcacia atgcctgatt ggcacctgat 240
gtaaccatta ctgaagattt gtgcaaatta ttttcatcac gcaacttttt gactaa 296

<210> 525

<211> 284

<212> DNA

<213> Glycine max
 <400> 525

gtggaagcct tgatgaagat gcagcttctg tgagactggt tgtggcacgt gggcatcgag 60
 gttctttagt ctcaatctta cagtaaaaat ctcggtctct atgctgaaag gattggagca 120
 atcaatgtga tttcatcgtc accagaatct gcagcaaggg taaagagcca actgaaaagg 180
 attgcccgac caatgtactc taatccaccg gtacacgggg ctaggatagt tgccgatgtt 240
 gttggaaacc cagttctctt taatgaatgg aaagcagaga tgga 284

<210> 526
 <211> 253
 <212> DNA
 <213> Glycine max

<400> 526

gaaaagaacc acattccctt ttttgatggt gcttaccagg ggtttgctag tggaagcctt 60
 gatgaagatg cagcttctgt gagactgttt gtggcacgtg gcatcgaggt tctttagtct 120
 caatcttaca gtaaaaatct cggctctctat gctgaaagga ttggagcaat caatgtgatt 180
 tcatcgtcac cagaatctgc agcaagggtg aagagccaac tgaaaaggat tgcccgacca 240
 atgaactcta atc 253

<210> 527
 <211> 262
 <212> DNA
 <213> Glycine max

<223> unsure at all n locations
 <400> 527

gcttcttcgt ttctatccgc agcttcgcac gctgtctcac cctcttggtc tctgtccacc 60
 acgcacaagg ganagcccat gcttggaggc aacactttga gatttcacaa aggacccaat 120
 tccttctcta gttcaaggtc tagaggtcgg atctctatgg ctggtgcagt taatgtatct 180
 cggtttgaag gcatacctat ggctcctcct gatccaattc toggagtttc cgaggcgttt 240
 aaggcagaca atagtgatgt ca 262

<210> 528
 <211> 277

<212> DNA
 <213> Glycine max
 <400> 528

ctacaacaca cttttgtaag tgattcggtc gcagaaacat ggcattctcg ttgctatccg 60
 cagcttcgca cgctgtctca cctcttgggt ctctgtccac cagcacaag ggatagccca 120
 tccttggagg caacactttg agatttcaca aaggacccaa ttctttctct agttcaaggt 180
 ctataggctcg gatctctatg gctgttgagc ttaatgtatc tcggtttgaa ggcataccta 240
 tggctcctcc tgatccaatt ctgggatttt ccgaggt 277

<210> 529
 <211> 266
 <212> DNA
 <213> Glycine max
 <400> 529

cgcacttcgc acgctgtctc accctcttgc tctctgtcca ccagcacaag gggacatcca 60
 ttcttggagg caacactttg agatttcaca aaggacccaa ttctttctct agttcaaggt 120
 ctagaggctcg gatctctatg gctgttgagc ttaatgtatc tcggtttgaa ggcataccta 180
 tggctcctcc tgatccaatt ctgggagttt ccgaggcggt taaggcagac aatagtgatg 240
 tcaagctcaa tcttggagtt ggggca 266

<210> 530
 <211> 257
 <212> DNA
 <213> Glycine max
 <400> 530

gtttccttca tcttcttctt cttcttctat ctctctacaa cacacttttt taagtgattc 60
 gttcgcagaa acatggcttc ttctgttcta tccgcagctt cgcacgctgt ctcacctct 120
 tgttctctgt ccaccacgca caagggaag cccatgcttg gaggcaacac tttgagattt 180
 cacaaaggac ccaattcctt ctctagttca aggtctagag gtcggatctc tatggctgtt 240
 gcagttaatg tatctcg 257

<210> 531
 <211> 271

<212> DNA
 <213> Glycine max
 <400> 531

gagatttcac aaaggacca attccttctc tagttcaagg tctagaggtc ggatctctat 60
 ggctgttgca gttaatgtat ctcggtttga aggcatacct atggctcttc ctgatccaat 120
 tctcggagtt tccgaggcgt ttaaggcaga caatagtgat gtcaagctca atcttggagt 180
 tggggcatac agaacagaag aactacagcc atatgtgctt atgttggtta gaaggtcttt 240
 gttccgtatt ttatgtgtct tctgtgattt g 271

<210> 532
 <211> 244
 <212> DNA
 <213> Glycine max
 <223> unsure at all n locations
 <400> 532

ctacaacaca cttttttaag tgattcgttc gcagaaacat ggcttcttcg nttctatccg 60
 cagcttcgca cgctgtctca nctcttggtc tctgtccanc acgcacaagg gagagcccat 120
 gcttggaggc aacactttga gatttcacaa aggacccaat tcctctctag ttcaaggctc 180
 agaggtcgga tctctatggc tgttgcagtt aatgtatctc ggtttgaagg catacctatg 240
 gcnc 244

<210> 533
 <211> 272
 <212> DNA
 <213> Glycine max
 <400> 533

cactgtttcc ttcattcttct tcttcttctt ctatctctct acaacacact tttttaagtg 60
 attcgttcgc agaaacatgg cttcttcggt tctatccgca gcttcgcacg ctgtctcacc 120
 ctcttgttct ctgtccacca cgacaaggga aagcccatgc ttggaggcaa cactttgaga 180
 tttcaciaag gacccaattc cttctctagt tcaagggtcta gaggtcggat ctctatggct 240
 gttgcagtta atgtatctcg gtttgaaggc at 272

<210> 534

<211> 288
 <212> DNA
 <213> Glycine max

 <223> unsure at all n locations
 <400> 534

 tgccgaattc cgctcgagct cgagccggtt tccntcatct tttttttttt cttctatctc 60
 tctacaacac actttttttaa cacattcggt cgcagaaaca tggtttcttc gtttctatcc 120
 gcagcttcgc acgctgtctc accctcttgt tctctgtcca ccacgcacaa gggacagccc 180
 atgcttggag gcaacacttt gagatttcac aaaggaccca attccttctc tagttcaagg 240
 tctagaggtc ggatctctat ggctgttgca gttaatgtat ctcggttt 288

<210> 535
 <211> 254
 <212> DNA
 <213> Glycine max

 <400> 535

 attttctatt gcagatggct tcgtcgggtc tctccgcagc ttgcactct gtctcaccct 60
 catgttctct gtccaccacg cacaagggaa agcccatgat tagagacaac actttgggat 120
 tccacagagg acccaattcc ttctctagtt caaggctag aggtcggatc tctatggctg 180
 ttgcagttaa cgtttctcgg tttgaaggca tacctatggc gctcctgat ccaattctag 240
 gagtttctga ggca 254

<210> 536
 <211> 272
 <212> DNA
 <213> Glycine max

 <223> unsure at all n locations
 <400> 536

 tgttctgttc tgtnctgna catctcgtna atcgnttana anttcttaac cgtnttctgt 60
 tgcagctggg cttctnctgt tatntaccgc agcttngcac gctgtntcac notcttgttc 120
 tctgtnnacc angcacaagg gaaagcacat gcttggaggc aacactttga gatttcacaa 180
 aggncccaat tccttctcta gttcaaggtc tagaggctcg atctctatgg ctgttgcagt 240
 taatgtatct cggtttgaag gcatacctat ng 272

<210> 537
 <211> 275
 <212> DNA
 <213> Glycine max

 <400> 537

 cctcgagccg attcggctcg aggttacatc tcgtgaattg ttacaatctg ttaaccattt 60
 tccattgcag atggcttcgt cacttctctc cgcagcttcg cactctgtct caccctcatg 120
 ttctctgtcc accacgcaca gggaaagccc atgattagag acaacacttt gggtttccac 180
 agaggaccca attccttctc tagttcaagg tctagaggtc ggatctctat ggctgttgca 240
 gttaacgttt ctcggtttga aggcatacct atggc 275

<210> 538
 <211> 277
 <212> DNA
 <213> Glycine max

 <223> unsure at all n locations
 <400> 538

 agaaacatgg cttcgtcggg tctctccgca gttcgcacn cctgtctcac cctcatgttc 60
 nctgtncacc acgcacaagg gnaagcccat gantagagac aanactttgg gattccacag 120
 aggacccaat tccttctcna gttcaaggtn tagaggctcg ntctctatgg ctgttgcaag 180
 taacgnttct cgggttngag gcatacctat gggcgctcc tgatccaaat tottagggag 240
 tttctgaggn atntaagggtg gaccaatagt ggtgtnc 277

<210> 539
 <211> 254
 <212> DNA
 <213> Glycine max

 <400> 539

 agattaatca atcatagata gatccattat tcatagttaa acataataac tgttgtgtta 60
 catctcgtga attgttacaa ctgcttaacc attttctatt gcagatggct tcgtcgggtc 120
 tctccgcagc ttgcactct gtctcaccct catgttctct gtccaccacg cacaaggga 180
 agcccatgat tagagacaac actttgggat tccacagagg acccaatttc ttctctagtt 240
 caaggcttag aggt 254

<210> 540
 <211> 267
 <212> DNA
 <213> Glycine max

 <400> 540

 atcgtattct ctacgctatt cctattaaat gaatcatagt catagataga tccattattc 60
 atagtttaaa ttaggaacct tttgtgttct gttctgttct gttacatctc gtgaatcggt 120
 tacaacttct taaccgtttt ctgttgcaga tggcttcttc gtttctatcc gcagcttcgc 180
 acgctgtctc accctcttgt tctctgtcca ccacgcacaa gggaaagccc atgcttgag 240
 gcaacacttt gagatttcac aaaggac 267

<210> 541
 <211> 259
 <212> DNA
 <213> Glycine max

 <400> 541

 cgctattcct attaaatgaa tcatagtcatt agatagatcc attattcata gtttaaatta 60
 ggaacctttt gtgctctgtt ctgttctgtt acatctcgtg aatcgtttac aacttcttaa 120
 ccgttttctg ttgcagatgg cttcttcgtt tctatccgca gcttcgcacg ctgtctcacc 180
 ctcttggttct ctgtccacca cgcacaaggg aaagcccatg cttggaggga acactttgag 240
 atttcacaaa ggacccaat 259

<210> 542
 <211> 259
 <212> DNA
 <213> Glycine max

 <400> 542

 tacgctattc cgattaatca atcatagata gatccattat tcatagttaa acataataac 60
 tgttgtgtta catctcgtga attgttacaa ctgcttaacc attttctatt gcagatggct 120
 tcgtcggttc tctccgcagc ttcgcactct gtctcaccct catgttctct gtccaccacg 180
 cacaaggagc agcccatgat tagagacaac actttggatt ccacagagga cccaattcaa 240
 tctctagttc aaggtctag 259

<210> 543
 <211> 270
 <212> DNA
 <213> Glycine max

 <400> 543

 ttcgtattct ctacgctatt ccgattaatc aatcatagat agatccatta ttcatagtta 60
 aacataataa ctgttggtgtt acatctcgtg aattgttaca actgtttaac cattttctat 120
 tgcagatggc ttctgcgggt ctctccgcag ctctgcactc tgtctcacc ccatgttctc 180
 tgtcaaccac gcacaaggga gagcccatga ttagagacaa cactttggga ttccacagag 240
 gacacaattc cttctctagt tcaaggtcta 270

<210> 544
 <211> 266
 <212> DNA
 <213> Glycine max

 <400> 544

 gcatacctat ggcgcctcct gatccaattc taggagtttc tgaggcattt aaggtggaca 60
 atagtgatgt caagctcaat cttggagttg gggcatacag aacagaagaa ctacagccat 120
 atgtgcttaa tgttggttaag aaggcagaga atcttatgct ggagagaggg gataacaaag 180
 agtatctccc aattgagggg tcggctgcat ttaataaggc aactgcagag ttgttacttg 240
 gagcagacaa cccagcaatc aaacag 266

<210> 545
 <211> 169
 <212> DNA
 <213> Glycine max

 <223> unsure at all n locations
 <400> 545

 cttgggagtt ggggcataca gaacagaaga actacagcca tatgtnccta atgttggtta 60
 gaaggcagag aatcttatgc tggagagagg ggataacaaa gagtatctcc caattgaggg 120
 tttggcagca ttttaataagg caactgcaga gttgttactc ggagcagac 169

<210> 546

<211> 272
 <212> DNA
 <213> Glycine max

 <400> 546

 ctatcctcgg ggtaactgtc gcttataaca aagatccaag tccagttaag ctcaacttgg 60
 gagttggtgc ttaccgaact gaggaaggaa aacctcttgt tttgaatgta gtgaggcgag 120
 ttgaacagca actcataaat gacgtgtcac gcaacaagga atatattccg atcgttgggc 180
 ttgctgattt taataaattg agtgctaagc ttatTTTTTgg ggctgacagc cctgctattc 240
 aagacaacag ggttaccact gttcaatgct tg 272

<210> 547
 <211> 270
 <212> DNA
 <213> Glycine max

 <400> 547

 cttccgcaaa tggcttctca cgacagcatc tccgcttctc caaactccgc ttctgattcc 60
 gtcttcaatc acctcgttcg tgctcccgaa gatcctatcc tgggggtaac tgtcgcttat 120
 aacaaagatc caagtccagt taagctcaac ttgggagttg gtgcttaccg aactgaggaa 180
 ggaaaacctc ttgttttgaa tgtagtgagg cgagttgaac agcaactcat aaatgacgtg 240
 tcacgcaaca aggaatatat tccgatcggt 270

<210> 548
 <211> 281
 <212> DNA
 <213> Glycine max

 <400> 548

 tgcaaattggc ttctcacgac agcatctccg cttctccaac ctccgcttct gattccgtct 60
 tcaatcacct cgttcgtgct cccgaagatc ctatcctcgg ggtaactgtc gcttataaca 120
 aagatccaag tccagttaag ctcaacttgg gagttggtgc ttaccgaact gaggaaggaa 180
 aacctcttgt tttgaatgta gtgaggcgag ttgaacagca actcataaat gacgtgtcac 240
 gcaacaagga atatattccg atcgttgggc ttgcggattt a 281

<210> 549

<211> 257
 <212> DNA
 <213> Glycine max

 <400> 549

 cgcttctgat tccgtcttca atcacctcgt tcgtgctccc gaagatccta tctcgggggt 60
 aactgtcgct tataacaaag atccaagtcc agttaagctc aacttgggag ttggtgctta 120
 ccgaactgag gaaggaaaac ctcttggttt gaatgtagtg aggcgagttg aacagcaact 180
 cataaatgac gtgtcacgca acaaggaata tattccgata gttgggcttg ctgattttaa 240
 taaattgagt gctaagc 257

<210> 550
 <211> 282
 <212> DNA
 <213> Glycine max

 <400> 550

 caacactctc tccagacact tccttcatca aatggcttct cacgacggca tctccgctgc 60
 ttcttcagat tccgtcttca atcacctcgt tcgtgctccc gaagatccta tctcgggggt 120
 aactgttgct tataacaaag atccaagtcc agttaagctc aacttgggag ttggtgctta 180
 ccgaactgag gaaggaaaac ctcttggttt gaatgtagtg aggcgagttg agcagcaact 240
 cataaatgac gtgtcacgca acaaggaata tattccgatt gt 282

<210> 551
 <211> 250
 <212> DNA
 <213> Glycine max

 <400> 551

 cttccgcaaa tggcttctca cgacagcatc tccgcttctc caacctccgc ttctgattcc 60
 gtcttcaatc acctcgttcg tgctcccgaa gatcctatcc tcggggtaac tgtcgcttat 120
 aacaaagatc caagtccagt taagctcaac ttgggagttg gtgcttaccg aactgaggaa 180
 ggaaaacctc ttgttttgaa tgtagtgagg cgagttgaac agcaactcat aaatgacgtg 240
 tcacgcaaca 250

<210> 552

<211> 273
 <212> DNA
 <213> Glycine max

 <400> 552

 ctcgctagac acttccttcc gcaaatggct tctcacgaca gcatctccgc ttctccaacc 60
 tccgcttctt attccttctt caatcacctc gttcgtgctc cogaagatcc tatcctcggg 120
 gtaactgtcg cttataacaa agatccaagt ccagttaagc tcaacttggg agttggtgct 180
 taccgaactg aggaaggaaa acctcttggt ttgaatgtag tgaggcgagt tgaacagcaa 240
 ctcataaatg acgtgtcacg caacaaggaa tat 273

<210> 553
 <211> 262
 <212> DNA
 <213> Glycine max

 <223> unsure at all n locations
 <400> 553

 ctgtgatcgc agactcaaca ctctcgctag acanttcctt ccgcaaattgg cttctcacga 60
 cagcatctcc gcttctccaa cctccgcttc tgattccgctc ttcaatcacc tcgttcgtn 120
 tcccgaagat cctatcctcg gggttaactnt ngcttataac aaagatccaa gtccagttaa 180
 gctcaacttg ggagttggtg cttaccgaac tgaggaagga aaacctcttg ttttgaatgt 240
 agtgaggcga gtgaacagca at 262

<210> 554
 <211> 239
 <212> DNA
 <213> Glycine max

 <223> unsure at all n locations
 <400> 554

 agttaagctc aacttgggag ttggtgctta ccgaactgag gaaggaaaac ctcttgtttt 60
 gaatgtagt angcgagttg aacagcaact cataaatgac gtgtcacgca acaaggaata 120
 tattccgatc gttgggcttg ctgattttaa taaattgagt gctaagctta tttttggggc 180
 tgacagccct gctattcaag acaacagggt taccactggt caatgcttgt ctggaactg 239

<210> 555

<211> 253
 <212> DNA
 <213> Glycine max

 <400> 555

 atggcttctc acgacggcat ctccgctgct tcttcagatt cagtcttcaa tcacctggtt 60
 cgtgctcccg aagatcctat cctcggggta actgttgctt ataacaaaga tccaagtcca 120
 gttaagctca acttgggagt tgggtgcttac cgaactgagg aaggaaaacc tottgttttg 180
 aatgtagtga ggcgagttga gcagcaactc ataaatgacg tgtcacgcaa caaggaatat 240
 attccgattg ttg 253

<210> 556
 <211> 252
 <212> DNA
 <213> Glycine max

 <400> 556

 tctaattcgt ggaggggaata cttttccatt acgcacgcac ttaattaca gacgagaaaa 60
 ttataattaa tagtaataca gacagcagca tgcgcccacc ggttattctc aaaactacca 120
 cctctctttt ggattcttct tcttcttcac caccctgtga tgcgagactc aacactctcg 180
 ctagacactt ccttccgcaa atggcttctc acgacagcat ctccgcttct ccaacctccg 240
 cttctgattc cg 252

<210> 557
 <211> 249
 <212> DNA
 <213> Glycine max

 <400> 557

 caaatggctt ctcacgacgg catctccgct gcttcttcag attccgtctt caatcacctc 60
 gttcgtgctc ccgaagatcc tatcctcggg gtaactgttg cttataacaa agatccaagt 120
 ccagttaagc tcaacttggg agttggtgct taccgaactg aggaaggaaa acctcttggt 180
 ttgaatgtag tgaggcgagt tgagcagcaa ctcataaatg acgtgtcacg caacaaggaa 240
 tatattccg 249

<210> 558

<211> 250
 <212> DNA
 <213> Glycine max

 <400> 558

 atggcttctc acgacggcat ctccgctgct tcttcagatt ccgtcttcaa tcacctcggt 60
 cgtgctcccg aagatcctat cctcggggta actgttgctt ataacacaga tccaagtcca 120
 gttaagctca acttgggagt tggtgcttac cgaactgagg aaggaaaacc tcttgttttg 180
 aatgtagtga ggcgagttga gcagcaactc ataaatgacg tgtcacgcaa caaggaatat 240
 attccgattg 250

<210> 559
 <211> 261
 <212> DNA
 <213> Glycine max

 <400> 559

 gttcatcgca gactcaacac tctctccaga cacttccttc atcaaatggc ttctcacgac 60
 ggcattctcg ctgcttcttc agattccgct tcaatcacc tcgttcgtgc tccogaagat 120
 cctatctctg ggggtactgtt gcttataaca aagatccaag tccagttaag ctcaacttgg 180
 gagttgggtgc ttaccgaact gaggaaggaa aacctcttgt tttgaatgta gtgaggcgag 240
 ttgagcagca actcataaat g 261

<210> 560
 <211> 248
 <212> DNA
 <213> Glycine max

 <223> unsure at all n locations
 <400> 560

 accaccctgt gatngcagac tcaacactct cgctagacac ttccttccgc aaatngcttc 60
 tcangacagc atctccgctt ctncacctc cgcntctgat tccgtottca atcacctcgt 120
 nngnnctcnc naanactcta tntcgggggt aactnnagct tataacaaag atccaagtnc 180
 agttaagctc aacttgggag ttggtgctta ccgaactgag gaaggaaaac ctcttgtttt 240
 gaatgtag 248

<210> 561
 <211> 235
 <212> DNA
 <213> Glycine max

<400> 561

gctcaacttg ggagttggtg cttaccgaac tgaggaagga aaacctottg ttttgaatgt 60
 agtgaggcga gttgaacagc aactcataaa tgacgtgtca cgcaacaagg aatatattcc 120
 gatcgttggg cttgctgatt ttaataaatt gagtgctaag cttatTTTTg gggctgacag 180
 ccctgctatt caagacaaca gggttaccac tgttcaatgc ttgtotggaa ctgggt 235

<210> 562
 <211> 260
 <212> DNA
 <213> Glycine max

<223> unsure at all n locations
 <400> 562

gttcatcgca gactcaacac tctctccaga cacttccttc atcaaattggc ttctncacga 60
 cggcatctcc gctgcttctt cagattccgt cttcaatcac ctggttcgtg ctcccgaaga 120
 tcctatcctc ggggtaactg ttgcttataa caaagatcca agtccagtta agctcaactt 180
 gggagttggt gcttaccgaa ctgaggaagg aaaacctott gttttgaatg tagtgaggcg 240
 agttgagcag caactcataa 260

<210> 563
 <211> 248
 <212> DNA
 <213> Glycine max

<400> 563

cagacacttc cttcatcaaa tggctttctca cgacggcatc tccgctgctt cttcagattc 60
 cgtcttcaat cacctcgttc gtgctcccgga agatcctatc ctgggggtaa ctgttgctta 120
 taacaaagat ccaagtccag ttaagctcaa cttgggagtt ggtgcttacc gaactgagga 180
 aggaaaacct cttgttttga atgtagtgag gcgagttgag cagcaactca taaatgacgt 240
 gtcacgca 248

<210> 564

<211> 266
 <212> DNA
 <213> Glycine max

 <400> 564

 ctttggattc ttattgttca tgcgagactc aacactctct ccagacactt ctttcatcaa 60
 atggcttctc acgacggcat ctccgctgct tcttcagatt ccgctttcaa tcacctcggt 120
 cgtgctcccg aagatcctat cctcggggta actgttgctt ataacaaaga tocaagtctt 180
 gttaagctca acttgggagt tgggtgcttac cgaactgagg aaggaaaacc ttttgttttg 240
 aatgtagtga ggcgagttga gcagca 266

<210> 565
 <211> 254
 <212> DNA
 <213> Glycine max

 <400> 565

 gttcatcgca gactcaacac tctctccaga cacttccttc atcaaattggc ttctcacgac 60
 ggcattctccg ctgcttcttc agattccgtc ttcaatcacc tcgttcgtgc tcccgaagat 120
 cctatcctcg gggtaactgt tgcttataac aaagatccaa gtccagttaa gctcaactgg 180
 gagttggtgc ttaccgaact gaggaaggaa aacctcttgt tttgaatgta gtgaagcgag 240
 ttgagcagca actc 254

<210> 566
 <211> 230
 <212> DNA
 <213> Glycine max

 <400> 566

 cacttccttc cgcaaattggc ttctcacgac agcatctccg cttctccaac ctccgcttct 60
 gattccgtct tcaatcacct cgtagttct cccgaagatc ctatcctcgg ggtaactgtc 120
 gcttataaca aagatccaag tccagttaag ctcaacttgg gagttggtgc ttaccgaact 180
 gaggtaggaa aacctcttgt tttgaatgta gtgaggcgag ttgaacagca 230

<210> 567
 <211> 249
 <212> DNA

<213> Glycine max

<400> 567

ttaaaaatga aataagaaaa actcaacttt gtaattcgtg gagggaatac ttttccatta 60
cgcacgcact ttaattacag acgagaaaaat tataattaat agtaatacag acagcagcat 120
gcgcccaccg gttattctca aaactaccac ctctcttttg gattcttttt cttcttcacc 180
accctgtgat cgcagactca acactctcgc tagacacttc cttccgcaaa tggcttctca 240
cgacagcat 249

<210> 568

<211> 266

<212> DNA

<213> Glycine max

<400> 568

cctcgagccg cttccgcaaa tcgcttctca cgacagcatc tccgcttctc caacctccgc 60
ttcaccttcc gtcttcaatc acctcggtcg tgctcccgaa gatcctatcc tcggggtaac 120
tgtcgcttat aacaaagatc caagtccagt taagctcaac ttgggagttg gtgcttaccg 180
aactgaggaa ggaaaacctc ttgttttgaa tgtagtgagg cgagttgaac agcaactcat 240
aaatgacgtg tcacgcaaca aggatt 266

<210> 569

<211> 269

<212> DNA

<213> Glycine max

<400> 569

ctcttattgt tcatcgcaga ctcaaacctc tctccagaca cttccttcat caaatggctt 60
ctcacgacgg catctccgct gcttcttcag attcogtott caatcaactc gttcgtgctc 120
ccgaagatcc tatcctcggg gtaactgttg cttataacaa agatccaagt ccagttaagc 180
tcaacttggg agttggtgct taccgaactg aggaaggaaa acctcttggt ttgaatgtag 240
tgaggcgagt tgagcagcaa ctcataaat 269

<210> 570

<211> 251

<212> DNA

<213> Glycine max

<400> 570

atcgcagact caacactctc tccagacact tccttcatta caatggcttc tcacgacggc 60
atctccgctg cttcttcaga ttccgttttc aatcacctcg ttctgtctcc cgaagatcct 120
atcctcgggg taactgttgc ttataacaaa gatccaagtc cagttaagct caaottggga 180
gttggtgctt accgaactga ggaaggaaaa cctcttgttt tgaatgtagt gaggcgagtt 240
gagcagcaac t 251

<210> 571

<211> 264

<212> DNA

<213> Glycine max

<223> unsure at all n locations

<400> 571

ccttcacaa atggcttctc acgacggcat ctccgtgct tcttcagatt ccgtcttcaa 60
tccacctcg tctgtctccc gaagatccta tcctcgggg aactgttgct tataacaaag 120
atccaagtc agttaanctc aacttgggan ttgggtgtac cgaactgagg aagggaanaac 180
ctcttgtttt gaatgtagtg aggcgagttg agcagcaact cataaatgan gtgtcncgca 240
acaagnattt nccnctggg gggg 264

<210> 572

<211> 260

<212> DNA

<213> Glycine max

<400> 572

tccatgcgc caccggttat tctcaaaact accacctctc ttttggattc ttcttcttct 60
tcaccaccct gtgatcgcag actcaacact ctctctagac acttcttcc gcaaactcgt 120
tctcagaca gcatctccgc ttctccaacc tccgttctg attcgtctt caatcacctc 180
gttcgtctc ccgaagatcc tatcctcggg gtaactatcg cttataacaa agatccaagt 240
ccagttaagc tcaacttggg 260

<210> 573

<211> 251

<212> DNA
 <213> Glycine max
 <400> 573
 tacggctgcg agaaggacag aagggtagcg ctgcgagaag acgacagaag ggggcagact 60
 caacactctc tccagacact tccttcatca aatggcttct cacgaaggca tctccgctgc 120
 ttcttcagat tccgtcttca atcacctcgt tcgtgctccc gaagatccta tcctcgggggt 180
 aactgttgct tataacaaag atccaagtcc agttaagctc aacttgggag ttgggtgotta 240
 ccgaactgag g 251

<210> 574
 <211> 185
 <212> DNA
 <213> Glycine max
 <400> 574
 ctcggggtaa ctgtcgctta taacaaagat ccaagtccag ttaagctcaa ctcgggagtt 60
 ggtgcttacc gaactgagga cagaaaacct cttgttttga atgtagtacg cgagttgaac 120
 agcaactcat aaatgacgtg tcacgcaaca aggaatatat tccgatcggt gggcttgctg 180
 atttt 185

<210> 575
 <211> 249
 <212> DNA
 <213> Glycine max
 <400> 575
 gaaagatcaa gactgcttat tctttgttct tcatctaacc caacgggata tgtctacccc 60
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 tctgatgaaa ttacgaaca cataatttat gcaccagcaa ctcacacgag ctttgcatct 180
 ttaccaggaa tgtgggacag aactcttact gtgaatggat tttctaaggc ctttgcaatg 240
 actggttg 249

<210> 576
 <211> 276
 <212> DNA
 <213> Glycine max

<400> 576

gatagcccga attgttgcaa agcaccccag gcttctggtt ctctctgatg aaatttacga 60
acacataatt tatgcaccag caactcacac gagctttgca tctttaccag gaatgtggga 120
cagaactctt actgtgaatg gattttctaa ggcctttgca atgactggtt ggcgggttgg 180
atatattgct ggtccaaaac attttgttgc agcatgtgga aagatccaaa gtcagtttac 240
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<210> 577

<211> 264

<212> DNA

<213> Glycine max

<223> unsure at all n locations

<400> 577

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gaatggattt tccaaggcct ttgcaatgan tggttggcgg cttggatata ttgctgggcc 180
aaaacacttt gttgcagcat gtggaaagat ccaaagtcag ttcacttcag gggccagtag 240
tatagctcag aaagctgcag ttgc 264

<210> 578

<211> 286

<212> DNA

<213> Glycine max

<400> 578

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tgggacagaa ctctaattgt gaatggactt tccaagacat ttgcaatgac tggttggcgg 180
cttgggtata ttgctgggcc aaaacatttt gttgctgcat gtgaaaagat tcaaagccag 240
tttacttcag gggcaagtag tatatctcag aaagctgggg ttgctg 286

<210> 579

<211> 233

<212> DNA

<213> Glycine max

<400> 579

gatagcccga attgttgcaa agcaccacag gcttctgggt ctctctgatg aaatttacga 60
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cagaactctt actgtgaatg gattttctaa ggcctttgca atgactgggt ggcggcttgg 180
atatattgct ggtccaaaac attttgttgc agcatgtgga aagatccaaa gtc 233

<210> 580

<211> 284

<212> DNA

<213> Glycine max

<400> 580

ggatttttcta aggcctttgc aatgactgggt tggcggcttg gatataattgc tgggtccaaaa 60
cattttgttg cagcatgtgg aaagatccaa agtcagttaa cttcaggggc cagtagtata 120
gctcagaaag ctgcagttgc tgcattagga ctaggccatg ctggtgggga ggcagtttct 180
accatggtga aagcatttag ggagcgaagg gatttcttag tacaaagttt tagagaaata 240
gatggcatca agatatctga accccagggga gcattttatc tatt 284

<210> 581

<211> 247

<212> DNA

<213> Glycine max

<400> 581

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gtgaatggat tttccaagac atttgcaatg actggttggc ggcttgggta cattgctgggt 120
acaaaacatt ttgttgagc atgcggaaag attcaaagtc agttcacttc aggtgcaagt 180
agtatatctc agaaagctgg agttgctgca ttaggactag gctatgctgg tggggaagct 240
gtttcaa 247

<210> 582

<211> 260

<212> DNA

<213> Glycine max

<223> unsure at all n locations
<400> 582

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agaatgattc gcttaatcac gagtacctcc ccgtgttggg gttcgaacca tttngtaaag 120
ctgctgtcac tcttttgctc ggtgacgtcg agacttccac acnactagcc gacgcnaggg 180
ctttnggagt gcaaacactg nggtggtatgg agcatangng ttacagntga atnccgagaa 240
aattcncata nannanattt 260

<210> 583
<211> 305
<212> DNA
<213> Glycine max

<400> 583

cgatgctaac tcttcaagct tcgtctcgta aagaaaatgc gaaggctcaa tagagagaac 60
tcaattgaat catcaaata ggacagtgat ttgcgcgttg atccattcca cgccttacat 120
tttcaggctc aatgccacgg cagcatccat caccatact tatatgtgac ctttttctat 180
cttactaaat acccaattcc ttctctaatt cacagtctac aggtctgatc tctatggctg 240
ttgcaattaa tgtatctcgg ttgaaagca tacctattgc tcctcctgat ccaattttta 300
gagtt 305

<210> 584
<211> 247
<212> DNA
<213> Glycine max

<400> 584

cccacgcgtc cgtacggctg caagaagacg acagaagggg agtaatacag acagcaacat 60
gcgcccagcg gttattctca aaactacat ctctcttttg gaggcgtcgt cgtcctcaac 120
accctgtgat ggcagactca aactctcgc tagacacgtc cttccacaaa tggcttctca 180
tgacatgatc tgagaatctt caacctacgc atctgaatcc gtcacatc atctcgttcg 240
tactccc 247

<210> 585
<211> 385

<212> DNA
 <213> Glycine max

 <223> unsure at all n locations
 <400> 585

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 tttgtggaat ctttcttctc gtcaccaccc tgtgatcgca gactcaacac tctcgtctaga 120
 cacttccttt cgcaaattggc ttctcacgac agcatctccg cttctacaac ctccgcttct 180
 gattccgtct tcaatcacct cgttcgtgct cccgaagatc ctatcctcgg ggtaactgtc 240
 gcttataaca aagatccaag tccagttaag ctcaacttgg gagttggtgc ttaccgaact 300
 gaggaaggaa aacctcttgt ttttgatgta gtgaggcgag ttgaacagnc actcataaat 360
 gacgtgtcac gcaacaagga atata 385

<210> 586
 <211> 455
 <212> DNA
 <213> Glycine max

 <223> unsure at all n locations
 <400> 586

 ctctccctct ctgttcgcac tctgtctttc cctgtttcc ggcgcactga gtcattggcg 60
 ttcgcaactc gtcaccggc caattcctcc gccgcagctc cgtcgccgga gcaaggctca 120
 tgtcttcttc gtcctcatgg ttccggagca tcgagccgc tcccaggat cctatcctcg 180
 gagtcactga agctttcctc gccgatcaga gtccaaacaa agtcaacgct ggagtgggtg 240
 cgtatcgcg tgaccacgga aaacctgtgg ttttggaatg tgtagagaa gcagagagga 300
 ggggtgccgg aagtcaattc atggagtatc ttcccatggg tggaagcata aaaatgatag 360
 aagaatcgct gaagctggca tttggagaca actctgagtt catcaaggat aaaagaatag 420
 ctgcagtga tgctntatct gngactggtg catgt 455

<210> 587
 <211> 360
 <212> DNA
 <213> Glycine max

 <400> 587

 gcgagcggcc gccctttttt tttttttttt tttttttttt tttttttttt ggggaaacgg 60

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aataaaaatg ttataatgct aaatctctgg atggagcccg gtaggcagaa aagtttcctt 120
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 agacaactcg ggttacagct gcatgtatcg cattcgccag aagtgggaca gttttggaac 300
 tcagaccagc catgctaata ctcccatcaa atgtcatgta tatatggaac tctttaatca 360

<210> 588
 <211> 366
 <212> DNA
 <213> Glycine max
 <400> 588

ctgcattgca tgtatctgca tcgagaatga tgttctgggt gtcaactgac aagtctatga 60
 caagtgggct tttgatatgg agcacatata gatggcttat ttgcctgtaa tgttcgaaag 120
 gacagtgaca ttgaactcct tggggaagac attctcotta acacgatgga agattgggtg 180
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 cgcaactgcc cattcttttc agagtgctgc tgcagcatct atgagagcac cagactctta 300
 ctatgtagag ctgaagaggg attatatggc atatagagct attttgattg aaggattgaa 360
 ggctgt 366

<210> 589
 <211> 413
 <212> DNA
 <213> Glycine max
 <400> 589

cttttgtggt ctgttctggt ctgttacata tcgtgaatcg tttacaactt cttaacggtt 60
 ttctgttgca gatggcttct tcgtttctat ccgcagcttc gcacgctgtc tcacctcttt 120
 gttctctgtc caccacgcac aagggaaagc ccatgcttgg aggcaacact ttgagatttc 180
 acaaaggacc caattccttc tctagttcaa ggtctagagg tcggatctct atggctgttg 240
 cagttaatgt atctcggttt gaaggcatac ctatggctcc tctgatcca attctcggag 300
 tttccgaggc gtttaaggca gacaatagtg atgtcaagct caatcttgga gttggggcat 360
 acagaacaga agaactacag ccatatgtgc ttaatgttgt taagaaggca gag 413

<210> 590
 <211> 401
 <212> DNA
 <213> Glycine max

<400> 590

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cttttgtgta tcgttctgtt ctgttacatc tcgtgaatcg gttacaactt cttaacggtt 60
ttctgttgca gatggcttct tcgtttctat ccgcagcttc gcacgctgtc tcacctctt 120
gttctctgtc caccacgcac aagggaaagc ccatgcttgg aggcaacact ttgagatttc 180
acaaaggacc caattccttc tctagttcaa ggtctagagg tcggatctct atggctgttg 240
cagttaatgt atctcggttt gaaggcatac ctatggctcc tcctgatcca attctcggag 300
tttccgaggc gtttaaggca gacaatagtg atgtcaagct caatcttga gttggggcat 360
acagaacaga agaactacag ccatatgtgc ttaatgttg t 401
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<210> 591
 <211> 331
 <212> DNA
 <213> Glycine max

<400> 591

```
gatcagttct gttctgttac atctcgtgaa tgatttacia ctaattaacc ggtgtctgtt 60
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gtccaccacg cacaaggga agcccatgct tggaggcaac actttgagat ttcacaaagg 180
accaattcc ttctctagtt caaggtctag aggtcggatc tctatggctg ttgcagataa 240
tgtatctcgg tttgaaggca tacctatggc tcctcctgat ccaattctcg gagtttccga 300
agcgtttaag catacaatat tgatgtcaag c 331
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<210> 592
 <211> 349
 <212> DNA
 <213> Glycine max

<400> 592

```
acggacgcga gaagacgaca gaaggggact actacttgat cacatcgtat tctctatgct 60
attccgatta atcaatcata gatagatcca ttattcatag ttaaacataa taactgttgt 120
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gttacatctc gtgaattggtt acaactgctt aaccattttc tattgcagat ggcttcgctc 180
 gttctctccg cagcttcaca ctctgtctca tcctcatggt ctctgtccac cagcacaag 240
 ggaaagccca tgattagaga caacactttg ggattccaca gaggacccaa ttccttctct 300
 agttcaaggt ctaaaggctc gatctctatg gctgttgacg ttaacgttt 349

<210> 593
 <211> 440
 <212> DNA
 <213> Glycine max
 <223> unsure at all n locations
 <400> 593

cggacgcgtg ggttccgcaa atggcttctc acgacagcat ctccgcttct ccaacctccg 60
 gttctgattc cgtgttcaat cacctcgctc gtgctcccga agatcctatc ctcggggtaa 120
 ctgtcgctta taacaaagat ccaagtccag ttaagctcaa cttgggagtt ggtgcttacc 180
 gaactgagga aggaaaacct cttgttttga atgtagtgag gcgagttgaa cagcaactca 240
 taaatgacgt gtcacgcaac atggaatata ttccgatcgt tgggcttgct gattttaata 300
 aattgagtgc taagcttatt tttggggctg acagccctgc tattcaagac aacaggggta 360
 ccaactgttca atgctngtct ggaactgggt ctttaagagt tgggggtgaa attttggtta 420
 aacactatca ccaacggact 440

<210> 594
 <211> 410
 <212> DNA
 <213> Glycine max
 <400> 594

cttccttccg caaatggctt ctacagacag catctccgct tctccaacct ccgcttctga 60
 ttccgtcttc aatcacctcg ttcgtgctcc cgaagatcct atcctcgggg taactgtcgc 120
 ttagaagaaa gatccaagtc cagttaagct caacttggga gttggtgctt accgaactga 180
 ggaaggaaaa cctcttggtt tgaatgtagt gaggcgagtt gaacagcaac tcataaatga 240
 cgtgtcacgc aacaaggaat atattccgat cgttgggctt gctgatttta ataaattgag 300
 tgctaagctt atttttgggg ctgacagccc tgctattcaa gacaacaggg ttaccactgt 360

tcaatgcttg tctggaactg gttctttaac actttgcggt gaatttttgg 410

<210> 595
 <211> 389
 <212> DNA
 <213> Glycine max
 <223> unsure at all n locations
 <400> 595

gtaattcgtg gaggggaatac ttttccatta cgcacgcaact ttaattacag acgagacaat 60
 tataattaat agtaatacag acagcagcat gcgcccaccg gttattctca aaactacgac 120
 ctctcttttg gattcttctt cttcttcacc accctgtgat cgcagactca acactctcgc 180
 tagacacttc cttccgcata tggcttctca cgacagcatc tccgcatcgc caaactccgc 240
 ttctggatcc gtcttcaagc acctcgtacg tgctcccgaa gatcctatcc tcggggtaac 300
 tgctcgcttac aacaaagatc cangtccagt taagctcaac ttgggagttg gtgcataccg 360
 aactgaggaa tgaaaacctc ttgttttga 389

<210> 596
 <211> 427
 <212> DNA
 <213> Glycine max
 <223> unsure at all n locations
 <400> 596

cccacgcgtc cgcccacgcg tccgcttttc tattctatta attacaggga ccatcaaaac 60
 caaaaaagcc aattaatagt tattcttttg gattcttatt gttcatcgca gactcaacac 120
 tctctccaga cacttccttc atcaaatggc ttctcacgac ggcattctcg ctgcttcttc 180
 agattccgtc ttcaatcacc tcgttcgtgc tccgaagat cctatcctcg gggtaactgt 240
 tgcttataac aaagatccaa gtccagttaa gctcaacttg ggagttggtg cttaccgaac 300
 tgaggaagga aaacctcttg ttttgaatgt agtgaggcga gttgagcagc aactcataaa 360
 tgacgtgtca cgcaacangg aatatattcc gattgttggg ctagctgatt ttaataaatt 420
 gagtgc 427

<210> 597
 <211> 405
 <212> DNA

<213> Glycine max

<400> 597

taaattatgt gttcataaat tatgcaccag caactcacac aagttttgca tctttaccag 60
gaatgtggga cagaactctt actgtgaatg gattttccaa ggcctttgca atgactgggt 120
ggcggcttgg atatattgct ggtccaaaac attttggtgc agcatgtgga aagatccaaa 180
gtcagttcac ttcagggggc agtagtatag ctacagaaagc tgcagttgct gcattaggac 240
taggccatgc tgggtggggag gcagtttcta ccatggtgaa agcatttagg gagcgaaggg 300
atttcttggg aaaaagtttt agagaaatag atggtgtcaa gatatctgaa cccaggggag 360
cattttatct attccttgat ttcagcttct attatggaag agaag 405

<210> 598

<211> 251

<212> DNA

<213> Zea mays

<400> 598

ctcaactcca tgggtgctcg caacaactcg gagaacgtgc tgctcccgt caacgagccg 60
gtgctagtaa ccaagcgccg cagccagata caaacgttcc tggaccacca cggcggcccc 120
ggcgtgcagc acatggcgct ggccagcgac gacgtgctaa ggacgctgag ggagtgcacg 180
ctagctcggc catgggcggc ttcgagttca atggcgccct caacatcgga ttattgacgg 240
cgtgtagcgg c 251

<210> 599

<211> 115

<212> DNA

<213> Zea mays

<400> 599

agcgctggcc agcgacgacg tgctcaggac gctgagggag atgcaggcgc gctcggccat 60
gggcggcttc gagttcatgg cgctcccac atccgactac tacgacggcg tgagg 115

<210> 600

<211> 368

<212> DNA

<213> Zea mays

<400> 600

aagtcacccc agccgcaaac tgcagctctg caagctacag aggccaccac gagtccacga 60

cgccacgccc tccgagagaa agagaaagag aaaaccaaag cacgataatg cccccgacct 120

ccacagccgc cgcagccggc gccgccgtgg cggcggcatc agcagcggag caggcggcgt 180

tccgcctcgt gggccaccgc aacttcgtcc gttcaaccc gcgctccgac cgcttccaca 240

cgctcgcgtt ccaccacgtg gagctctggt gcgccgacgc ggctccgcc gcggggcgcgt 300

tctccttcgg cctggggcgc ccgctcgcgc cgcgctccga cctctccacg ggcaactccg 360

cgcacgcg 368

<210> 601

<211> 259

<212> DNA

<213> Glycine max

<223> unsure at all n locations

<400> 601

accgtgccgc tgatgtgttg accgttgacc agattaagca gtgtgaggag cttgggattc 60

ttgttgacag anatgatcag ggactctgc ttcagatttt caccaagcct gttggggaca 120

ggccantcga tattcataga gataattcag aggatcgggt gcatggtgga ngatgangaa 180

gggaaggtgt acatccangg tncatgtggg ggttttggga aaggcanttt tctgagcttt 240

caaatccatt gaagatatg 259

<210> 602

<211> 269

<212> DNA

<213> Glycine max

<400> 602

gctgcctcct ccgcctccat tcccagtttc gacgccgcca cctgccttgc cttecgctgcc 60

aaacacggct tcggcgtccg cgccatcgcc ttggaagtcg ccgacgcgga agccgctttc 120

agcgcacgag tcgcgaaagg agccgagccg gcgctgcgcgc cggttctcgt cgacgatcgc 180

accggcttcg cggaggtgcg cctctacggc gacgtggtgc tccgctacgt cagctacaag 240

gacgccgcgc catagcccca cacgcagat 269

<210> 603
 <211> 268
 <212> DNA
 <213> Glycine max

<400> 603

ottgggattc ttgttgacag agatgatcag ggcactctgc ttcagatttt caccaagcct 60
 gttggggaca ggccaacgat attcatagag ataattcaga ggatcgggtg catggtggag 120
 gatgaggaag ggaaggtgta ccagaagggg gcatgtgggg gttttgggaa aggcaatttt 180
 tctgagcttt tcaaattccat tgaagaatat gagaagactt tggaagctaa aagaaccgcg 240
 taagcacatt ggaagaacac aaatactc 268

<210> 604
 <211> 257
 <212> DNA
 <213> Glycine max

<400> 604

gttgacagag atgatcaggg cactctgctt cagattttca ccaagcctgt tggggacagg 60
 ccaacgatat tcatagagat aattcagagg atcgggtgca tgggtggagga tgaggaaggg 120
 aaggtgtacc agaaggggtgc atgtgggggt tttgggaaag gcaatttttc tgagcttttc 180
 aaatccattg aagaatatga gaagactttg gaagctaaaa gaaccgcgta agcacattgg 240
 aagaacacaa atactcc 257

<210> 605
 <211> 265
 <212> DNA
 <213> Glycine max

<400> 605

taagcagtgt gaggagcttg ggattcttgt tgacagagat gatcagggca ctctgcttca 60
 gattttcacc aagcctgttg gggacagggc aacgatattc atacagataa ttcagaggat 120
 ccggtgcatg gtggaggatg acgaacggaa cgtgtagcag aacggtgcat gtggggggtt 180
 tgggaaaggc aatttttctg agcttttcaa atccattgga gaatatgaga acactttggg 240
 agctaaaaga accgcgtaag cacat 265

<210> 606
 <211> 473
 <212> DNA
 <213> Glycine max

<400> 606

accggcttcg cggaggtgcg cctctacggc gacgtggtgc tccgctacgt cagctacaag 60
 gacgccgcgc cgcattgcgc acacgcagat ccgtcgcggt ggttcctgcc gggattcgag 120
 gccgcggcgt cgtcgtcttc gtttccggag ctggactacg ggatccggcg gctggaccac 180
 gccgtcggga acgttccgga gctggcgccg gcggtgaggt acctgaaagg cttcagcgga 240
 ttccacgagt tcgcggagtt caccgtggag gacgtgggaa cgagcgagag cgggttgaac 300
 tcggtggttc tggcgaacaa ctccgagacg gtgttgctgc cgctgaacga gccggtttac 360
 ggaacgaaga ggaagagcca gattgagacg tatttggaa acagcgaatg tgctggtgtg 420
 cagcaccttg cgcttggttac tcacgacatc ttaccacac tgagagagat gag 473

<210> 607
 <211> 441
 <212> DNA
 <213> Glycine max

<223> unsure at all n locations
 <400> 607

gccaatatcc atgtgcaacg aaattcaagc ccaagcccaa gcccaagccc aagcccaacc 60
 tgggttgaag ctctcgcggt gcaagaactt cgtccgaacc aatcctaagt cggaccgctt 120
 tcaagtcaac cgcttccacc acatcgagtt ctggtgcacc gatgccacca acgcctctcg 180
 ccgattctct tggggacttg gaatgcctat tgtggcaaaa tctgatctct ccaccgaaa 240
 ccaaattcac gcctcctacc tcctccgctc cggcgacctc tccttctct tctccgctcc 300
 ttactctccc tctctctccg ccggtcctc cgctgcctcc tcgcctcca tcccagttt 360
 cgacgccgnc acctgccttg ccttcgctgc caaacacggc ttccggcgtcc gcgccatcgc 420
 cttggaagtc gccgacgcgg a 441

<210> 608
 <211> 304
 <212> DNA
 <213> Zea mays

<223> unsure at all n locations
 <400> 608

gacntggctg tccggcgccc attttcagct ccctgatctt ggcccaattg gtgagcatgg 60
 nntggcttcg ccgagggatt tcctttcccc gacagcatgg tttgagcagg agcaccaccc 120
 tggatacaca atagtgcaca agtatggtgg cgagctgttc agcgccacgc aggatttctc 180
 tccattcaac gtggtcgcgt ggcatgggaa ttatgtccct tacaagtatg atctgagtaa 240
 gttctgtcca ttcaacaccg tcctcttgga tatggcgacc gtcagtgaac acagttctaa 300
 ctgc 304

<210> 609
 <211> 266
 <212> DNA
 <213> Zea mays

<400> 609
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 cgcgtggcta tgtctctgag atcttcggcg cccattttca gtcacctgat cttggcccaa 120
 ttggtgccaa tggtcttggt tcgccgaggg atttcctttc cccgacagca tggtttgagc 180
 aggagcacca ccctggatac acaatagtgc acaagtatgg tggcgagctg ttcagcgcca 240
 cgcaggattt ctctccattc aacgtg 266

<210> 610
 <211> 282
 <212> DNA
 <213> Zea mays

<400> 610
 gtcccttaca agtatgatct gagtaagttc tgtccattca acaccgtcct cttggatcat 60
 ggcgaccgt cagtgaacac agttctaact gcgccaactg ataagcctgg cgtcgcgttg 120
 cttgattttg taatattccc acccagatgg ctggttgctg agaatacatt ccgcccaccc 180
 tactaccacc gcaactgcat gagcgaattc atgggcctca tctatgggat gtacgaggct 240
 aaggccgatg gttttcttcc tgggtggcgcc agcttcacag ct 282

<210> 611
 <211> 272

<212> DNA
 <213> Zea mays

<400> 611

ctacaccgtc tgcggcgccg gcagctcatg cctccgacac ggatacgcca tccacatgta 60
 tgctgctaac aagcccatgg atggatgctc cttgtgcaat ggggacggtg acttctcat 120
 tgttccccag caaggaaggt tattatcaca accgagtgcg gaaggctgct ggtttcaccc 180
 ggcgagatcg tcgtgatccc tcaaggtctc cgatttgctg tcgacttgcc ggatggcccc 240
 tcgcgtggct atgtctctga gatcttcggc gc 272

<210> 612
 <211> 253
 <212> DNA
 <213> Zea mays

<400> 612

ctacaccgtc tgcggcgccg gcagctcatg cctccgacac ggatacgcca tccacatgta 60
 tgctgctaac aagcccatgg atggatgctc cttgtgcaat ggggacggtg acttctcat 120
 tgttccccag caaggaaggt tttatcaca accgagtgcg gaaggctgct ggtttcaccc 180
 ggcgagatcg tcgtgatccc tcaaggtctc cgatttgctg tcgacttgcc ggatggcccc 240
 tcgcgtggct atg 253

<210> 613
 <211> 295
 <212> DNA
 <213> Zea mays

<400> 613

ctcgacaagc aatggccatg gaggaggagc agacaccacc cgagctgcgc tacctctcgg 60
 gcctgggcaa caccttcacg tcggaggcgg tgccggggtc gctccccgtg gggcagaaca 120
 acccgctagt gtgcccgctg ggactctacg ccgagcagct ctccggcacc tccttcacca 180
 ccccgcgcg cccgaacctg cgcacgtggc tgtaccggat caagccgtcg gtgaccacg 240
 aacccttcta tccgcggaac cccaccaacg agcgccctcg cggcgagtgc gaccg 295

<210> 614
 <211> 293

<212> DNA
 <213> Zea mays

<400> 614

ccgttgccgg cttgccccgt ccgtgcgctc atctgtttcc accttggaac ctgacaagc 60
 aatggccatg gaggaggagc agacaccacc cgagctgcgc tacctctcgg gcctggggca 120
 acaccttcac gtcggacgcg gtgccgggggt cgctccccga ggggcagaac aaccgcctag 180
 tgtgcccgtt gggactctac gccgagcagc tctccggcac ctcttcacc acaccgcgcg 240
 cccggaacct gcgcacgtgg ctgtaccgga tcaagccgtc ggtgaccac gaa 293

<210> 615
 <211> 449
 <212> DNA
 <213> Zea mays

<400> 615

cggacgcgtg ggattgtttt gtcacaccga gaaccatac ttacctaaac tgtgtgtgtg 60
 tgtgcagggtg ccaatggctt ggcttcgccg agggatttcc tttccccgac agcatgggtt 120
 gagcaggagc accaccctgg atacacaata gtgcacaagt atggtggcga gctgttcagc 180
 gccacgcagg atttctctcc attcaacgtg gtcgcgtggc atgggaatta tgtcccttac 240
 aaggtgtgtt gtatgccatt gtacacctgt ctgccattga gatgtgtgtc gctgttcact 300
 ccacccccctt ctctttcagt atgatctgag taagttctgt ccattcaaca ccgtcctctt 360
 ggatcatggc gaccgcagc tgaacacagt tctaactgcg ccaactgata agcctggcgt 420
 cgcgttgctt gattttgtaa tattccac 449

<210> 616
 <211> 212
 <212> DNA
 <213> Glycine max

<400> 616

atgaggccaa ggctgatgga tttcttcccg gtggtgcaag tctccataat tgtatgactc 60
 cccatggctc tgatacaaag tcatatgagg ctaccattgc acgaggaaat gatggaggac 120
 cttgtaagat cacggacaca atggctttta tgtttgatc gagtttgata ccccgatatc 180
 gtcaatgggc cctggaatca ccgttcttgg at 212

<210> 617
 <211> 269
 <212> DNA
 <213> Glycine max

 <400> 617

 cgacggtggc gagttcgtgt acctttccgg gttcggcaac cactttctct ccgaggccct 60
 cgccggagct ctgccggtgg cgcagaacag cccctcgtc tgcccgtagc gcctctacgc 120
 cgagcaaata tctggcacct cttcacctc cctcgcaac cgcaacctct tcagttgggt 180
 ttatcggatc aagccatcgg tgactcacga accgttcaag cctagggtag ctggtaatgg 240
 cagaattttg agtgagtta acaactcca 269

<210> 618
 <211> 269
 <212> DNA
 <213> Glycine max

 <400> 618

 ctttgtgttc actctttctc ttttttggtg ttagttcggg gaatcatgga gaaccaatac 60
 gacggtggcg agttcgtgta cttttccggg ttccggcaacc acttctctc ccgaggccctc 120
 gccggagctc tgccggtggc gcagaacagc cccctcgctc gcccgtagc cctctacgcc 180
 gagcaaatac ctggcacctc cttcacctc cctcgcaacc gcaacctctt cagttgggtt 240
 tatcggatca agccatcggg gactcacga 269

<210> 619
 <211> 285
 <212> DNA
 <213> Glycine max

 <400> 619

 attcggctcg agacaaatac taccatttcg gtgaatcatg gcgaacccaa tcgacggtgg 60
 cgagttcgag tgccctttccg ggttcggcaa ccacttctcc tccgaggccc tcgccggagc 120
 tctgccggcg gcgcagaaca gcccctcgt ctgccgtac ggactatacg ccgagcaaat 180
 ctccggcacc tccttcactt ctctcgcaa ccgcaacctc ttcagttggg tttatcggat 240
 caaacatca gtgactcacg aaccgttcaa gccaaagata ccggg 285

<210> 620
 <211> 255
 <212> DNA
 <213> Glycine max

 <223> unsure at all n locations
 <400> 620

 gngatttaag aagttcaatt ctttactcaa actttgtgtt cactctttct cttttttggt 60
 gttagttcgg tgaatcatgg agaacccaat cgacggtggc gagttcgtgt acctttccgg 120
 gttcggcaac cacttctctc cgaggccctc gccggagctc tgccggtggc gcagaacagc 180
 cccctcgtct gcccgtagcg cctctacgcc gagcaaatct ctggcacctc cttcacctcc 240
 cctcgcaacc gcaac 255

<210> 621
 <211> 257
 <212> DNA
 <213> Glycine max

 <400> 621

 aattatgttc catatatgta tgatttaaac aaattctgcc cttataatac agttctgttt 60
 gatcatagt atccatcaat caatactgtg ttgacagcac caactgataa acctggagtg 120
 gcattgcttg attttgtcat tttcccaccc agatggctgg ttgctgagca taactttccg 180
 cctccatatt atcatcgcaa ttgcatgagt gaatttatgg gcctcattca tgggtggttat 240
 gaggccaagg ctgatgg 257

<210> 622
 <211> 225
 <212> DNA
 <213> Zea mays

 <400> 622

 cgagcccatc gccgtcctcg ccggggacgc gctgctctcg ctctccttcc accacatggc 60
 cagcgtcggg tcctaccctc cggacgtgga cccggagaag caccocgcc gcgtcgtccg 120
 agccattggg gagctcgcgc gctgcatcgg atccgaggga ctcgtcgccg gccaggttgt 180
 cgatctcgag atgacgggca catcagagac ggtgcccctc gaacg 225

<210> 623
 <211> 337
 <212> DNA
 <213> Zea mays

 <400> 623

 gtgccggcag cgactattcc tgatgccacg acgacaagcg tcaactgagcg gacttcggtt 60
 tcatctcttt tagaggttgt atcgaggagc ttgctcagcc ttaacaacaa tctcaaatacg 120
 cttgtttggtg cagaaaaatcc agtttttagtt tctgcagctg aacaaatttt tgggtgctggt 180
 ggaaaaagat taaggccagc attggttttc ctgggtgtcta gagcaactgc tgaattagct 240
 ggtttgtcgg agttaactgc agaacatcga cgcttggcag agattatcga gatgattcac 300
 actgcgagtt taatacatga tgatgtcata gatgata 337

<210> 624
 <211> 350
 <212> DNA
 <213> Zea mays

 <400> 624

 caagaccgcc gcattgctcg aggcctcggg tgtgattggg gcgatcatcg gaggcggcgc 60
 tgacgagcag atcgagaggg tgtggaagta cgcgaggctc atcgggctgc tgttccaggt 120
 ggtcgacgac atactcgatg tcaccaagtc gtcagaggag ctcggaaga cagcggggaa 180
 ggacctggca agcgacaaaa cgacgtaccc taagctgctg gggctagaaa agtcgcggga 240
 gttcgcgagg gagttgctct ctgatgccgt atagcagctt gcttgcttcg acaaggagaa 300
 ggcagcgctt ctgttgcatc tggccaacta tatcgtccat atgcacaact 350

<210> 625
 <211> 245
 <212> DNA
 <213> Glycine max

 <400> 625

 ttgaagggtt attcagaaga cccatttcc cctgctaggc tttttgaagt ggttgccgat 60
 gatctgctaa ctctcaataa aaatcttcag tcgattgtag gagcagaaaa tccagttttg 120
 atgtctgcag ctgagcagat ttttagtgct ggtggaaaga ggatgagacc agctttggtg 180

ttcttgggtgt caagggcgac tgcagagtta cttggcttga aggaacttac tgcaaagcat 240
cgacg 245

<210> 626
<211> 273
<212> DNA
<213> Glycine max

<400> 626

gctcgagcac ttgtcccgcc acaagccctt ctgtaccaat cgatcttgct aactccccaa 60
tcgcgcaaac cacgcgtgac gccgatacgc cctccgtgga caccgccacg tgctcaaacg 120
cgaaggcgag aactgccacg tcctcgctct agaccttggt gttggtcggc tttccgtggg 180
agaggtcgtc gttgtccata tagggcaggt tgctgtggat gagcgccatg gtgccgttga 240
cgagctcgca tgtgggtgat cagagcacgg ggc 273

<210> 627
<211> 270
<212> DNA
<213> Glycine max

<400> 627

cagagaaatt tatttgagtg gttcccccgt gagaaaacag ggtatccaat gttttcactt 60
ttaattttgc ctataagcaa tgtaattggt taatgcaaac aaggagccg cctttggagg 120
atcgaagcca gacaattgtt ccttggcatc cttaacaat tcttgagcaa attcctttga 180
cttatctatc cccaatagct tgggataagt aaccttatca gccaccaaatt ccttccccgc 240
cgttttcccc aattcctcgg acgacttcgt 270